EFFECTS OF *Spirodella polyrhiza* EXTRACTS ON WHEAT CROP

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CERTIFICATE

This is to certify that Mr. Anant Kumar Tripathi of Pt. Jawaharlal Nehru P. G. College, Banda has worked under my supervision on the problem "**EFFECTS OF *Spirodella polyrhiza* EXTRACTS ON WHEAT CROP**" for the degree of **Doctor of Philosophy** of Bundelkhand University, Jhansi. The accompanying thesis presented embodies the work of candidate himself carried out in well over 200 days.

A.K. AWASTHI

PREFACE

Wheat ranks only second to rice in vital significance as a cereal. In terms of both area and production, India today occupies fourth place among wheat growing countries of the world and produces more than 30 million tonnes annually.

The crop is grown in the country with about 84 percent of wheat growing areas spread in Uttar Pradesh, Punjab, Madhya Pradesh, Rajasthan, Bihar and Haryana, producing nearly 87 percent of Indian wheat. The other states which have sizeable area under wheat cultivation are Maharashtra, Gujarat, West Bengal, Karnataka and Himanchal Pradesh.

Although wheat production was more than doubled during last few years, there is not significant increase in per-capita availability of wheat because of continuous increase in population.

The National Commission on Agriculture of India estimated that the wheat needs of the country in 1975 were 24.23 million tonnes. The wheat harvest was 26.4 million tonnes

in 1972 with a surplus of 2.2 million tonnes. It was estimated that the country needed 30.05 million tonnes of wheat in 1981 and 33.39 million tonnes in 1985. Taking into the account the increased tempo in augmenting irrigational resources and fertilizers output the commission envisages that the additional wheat production to meet this demand has to be achieved not by increasing the area but by increasing the production per unit area. The entire area being under high yielding varieties, the National Commission on Agriculture visualizes that productivities of rainfed wheats would be stepped up through appropriate breeding, agronomy, plant protection measures and water conservation practices. It has been repeatedly shown that the existing varieties are capable of giving 50 to 60 percent more yield if proper agronomic practices and production technology are followed.

The rapid spread of aquatic weeds in tropical and subtropical regions of the world has aroused growing concern and has opened up wide vistas for further exploration and enquiry. Weed problem exists world wide but no where it bears relevance as in South-East Asia, especially in India. Encroachment of aquatic weeds in varied-environments has cropped up as a socio-economic problem. India is particularly vulnerable due to its wide spread.

Out of Indian aquatic vegetation ten common weeds including ***Spirodella polyrhiza*** are well known as noxious weeds. ***Spirodella polyrhiza*** is free floating minute plant distributed in seventy seven districts of India and causes concern in forty six districts. It impounds water, retards growth of cultivated plants, makes water impotable, increases loss of water, causes disease problems and provides hinderance to aquatic sports and fisheries.

Hillman (1961) while reviewing the research work concerned with Lemnaceae has pointed out areas of futurestic research. Some of the areas needing attention included : Precise repetition of experiments depends on the use of the same clone, medium, stock conditions and experimental period, among other factors. Trace metal nutrition, pH and other medium variables change with time in culture, may interact in a complex fashion, and should not be left entirely to untested assumptions in a given series of experiments; plants from older cultures may differ from those in younger cultures in many respects. Increase in frond number is exponential under good culture conditions, but is not analogous to the growth of microorganisms by simple division. Annual cycles in frond multiplication rate and other growth values under constant light and temperature have been reported, but

require confirmation under conditions controlling as many other variables (e.g., air pollution) as possible. Certain species are able to grow in darkness if supplied with minerals and sucrose; others will not do so unless given additional supplements or low doses of red light. Roots do not elongate except under normal light conditions. The nature of these dark-induced blocks in growth is unknown. Growth in aseptic culture is often promoted by the addition of organic compounds to the basic mineral medium. Sugars promote growth only under suboptimal light supply. Many other compounds may promote growth by improving trace-element availability as complexes, or buffering pH changes. The question whether such compounds would promote growth under optimal conditions of light, temperature and inorganic nutrition remains unanswered. The cycle of "Senescence and rejuvenation" in vegetative, reproductive, and its modification by external factors, offer an excellent model system for the study of aging. It is also an important consideration in any other study in which small numbers of individuals are used. However, Hillman also could not coin the idea of utilizing lemnoids as source for obtaining extracts containing growth substances to boost growth and yield of crop plants. Present investigation is aimed to fill part of this vacuum in the existing knowledge of lemnoids.

The minute size of ***Spirodella polyrhiza*** coupled with all attributes of an angiosperm, ease of ***in vitro*** culture and possibility for experimental manoeuvring of complete plant accrues considerable significance to it as an ideal experimental material for its ***in vitro*** mass culture to serve as a source for obtaining extracts containing growth substances.

Despite, scientific attainment and massive development of technology and tremendous advance achieved, and bringing the country on threshold of self-sufficiency, the constantly growing population influx is likely to multiply nation's demand as projected in futurestic needs of the cereal.

There is as such a need for keeping alive a spirit of investigation in frontiers of knowledge to evolve and understand various aspects relating to growth and yield of the crop which depends largely on its metabolism and anatomy. One of the significant aspects of study to multiply growth and yield of crops is the influence of growth substances in extracts of a variety of plants.

Estimated trends of ***Spirodella polyrhiza*** infestations are suggestive of their increase in majority of districts or else infestation remains constant but a decline has been scarcely reported. Naturally, such luxurience of infestation coupled

with attributes referred to earlier is proven with possibilities to study effects of ***Spirodella polyrhiza*** extracts on anatomy, growth, development, certain metabolites and plant constituents, and productivity of wheat crop. How best this knowledge can be used to benefit mankind forms the basic theme of this thesis.

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Date : Dec. 19th 2001
Place : Banda.

Anant Kumar Tripathi

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INTRODUCTION

INTRODUCTION

The dynamic features of aquatic habitats in South East Asia in general and India in particular have supported luxuriant growth of aquatic weeds. Studies have been made for their utilization in multiple ways in developing countries. Aquatic weeds are known to cause problems of varied nature like covering of impounded water, hindrance to fisheries, suppressing growth of cultivated plants, making water impotable, increasing loss of water, creating disease problems, causing impediment to navigation and hindrance to aquatic sports. Besides, such problems they also supplement as sources of fodder, green manure and fish food. In view of the significance of noxious aquatic vegetation, a general consciousness among scientists working in different regions of South-East Asia was evolved to pinpoint problems associated with vast community of aquatic plants and explore possibilities of their utilization for benefit of mankind.

Habitats with standing water for most of the year may dry out completely in the summer whilst normally terrestrial soils may be flooded during rainy season. At no time there is an abrupt change from dry to waterlogged to submerged soils. Some of the sites that are periodically flooded support distinctive associations (Guppy, 1895; Hicks, 1937; Luther, 1951).

There are essentially similar reports of habitats in Europe and America. Comparable habitats have been observed elsewhere (Butcher, 1933; Olsen, 1950; Lundh, 1951; Kamuro, 1957; Zaki, 1960; Niemi, 1962; Doignon, 1963; Forsberg, 1964 and others). Pearsall's (1917; 1921) pioneer research supplemented by that of Misra (1938), provides data on the floristic composition and succession of hydrophyte communities and other environmental factors influencing their distribution.

Pioneer floristic study in continental Europe was that of Maganin of Jura Lakes. The early work on aquatic plant communities was purely descriptive and attention was not focussed on dynamic successional aspects (Wohlschilag, 1950; Penfound, 1953; Swindale and Curtis, 1957; Curtis, 1959; Odum, Burkholder and Rivero, 1959; Phillips, 1960; Havly, 1961; Odum, 1963; Stookey, Fore and Mohlenbrock, 1964 and numerous other workers). Literature supports survey of

aquatic weeds from India (Mirashi, 1954; Patnaik and Patnaik, 1956; Srivastava, 1956; Murty and Singh, 1960; Chavan, 1961; Subramanyam, 1962; Bhambie, 1966; Varshney and Singh, 1973 and Pandey, 1979). Aquatic plants are known to cause severe problems. Aquatic vegetation of Kanpur has been studied in some detail by Bhambie (1966) and Pandey (1979). A preliminary survey of Lemnoids in Banda has been made by Tripathi and Awasthi (2000). In their systematic descriptions of aquatic angiosperms ***S.polyrhiza*** has also been reported.

Out of variety of aquatic plants, duckweeds comprise simplest and smallest of flowering plants relegated as botanical curiosities. They have been described as plants without known economic significance in the beginning but now their relevance as fish and duckfood has attracted attention. Nowinska and Rzesa (1972) pointed out the importance of ***S.polyrhiza*** as a poor man's food for Polish, Burmese and Thai people. They reported an estimated yield of 265 tonnes of green matter per hectare and 2080 kgm of protein per hectare. There are also reports of endogenous gibberellins in floating plants and turions of ***Wolffiella floridana*** (Pieterse, Bhalla and Sabharwal, 1971). It is known that gibberellins have an effect on dormancy and as such duckweeds may prove useful as

PHOTO - 1 : SHOWING PROFUSE GROWTH OF ***Spirodella polyrhiza*** IN A POND AT ALLAHABAD ROAD, BANDA

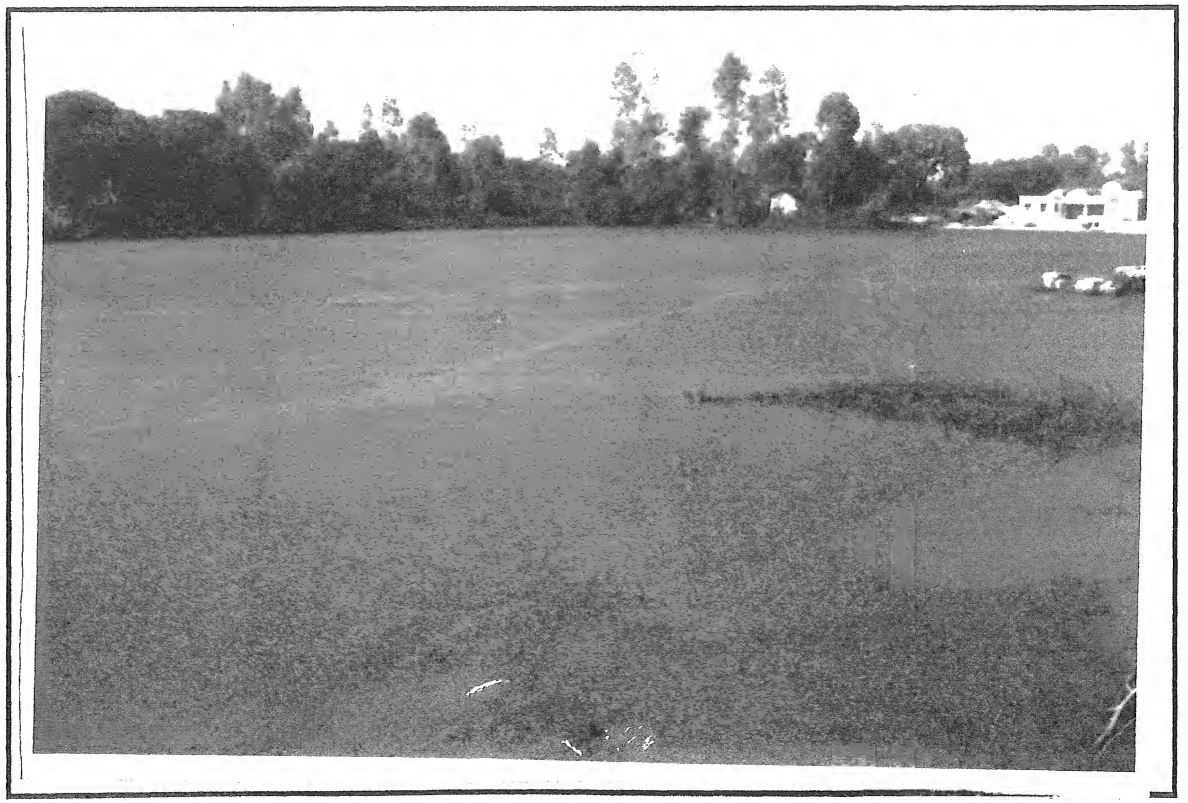
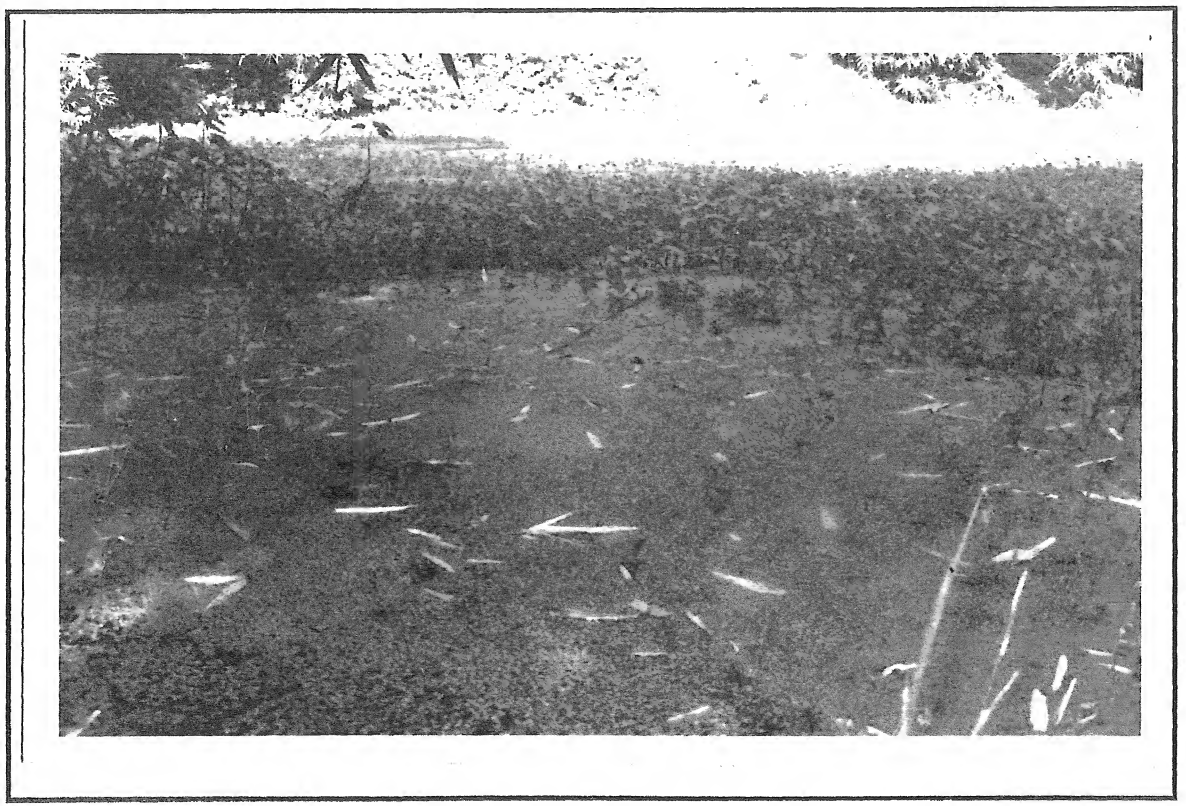


PHOTO - 2 : SHOWING PROFUSE GROWTH OF ***Spirodella polyrhiza*** IN A POND AT NARAINI ROAD, BANDA



experimental material for studying dormancy and also serve towards extraction of growth substances for utilization in agriculture. Duckweeds have been found to be unusually suited for biochemical studies and plant nutrition (Reid and Bieleski, 1970). The overwhelming usage of lemnoids as experimental organisms in morphogenetic, physiological biochemical and genetical research has opened up wide vistas for exploration and enquiry. A closer examination of these facts would be of interest to depict totality of their significance as mentioned below.

The duckweeds have been rated among ten major noxious weeds (Varshney and Singh, 1973) causing major problems in forty six districts, out of their total occurrence in 77 districts in India. It is interesting to remark that estimated trends of duckweed infestations increased in 12 districts, a decline is marked only in one while in 8 districts constant growth manifests. It may thus, be concluded that lemnoids harbour increased distribution and are potentially useful for their multiple values. The growth, distribution and periodicity of duckweeds of Banda were studied with a view to emphasise their significance by Tripathi and Awasthi (2000).

Lemnoids explicit particular features which place them

above par organisms like fruitflies and breadmolds for simplicity in their structure and small size. They are of distinct advantage over micro-organisms as a tool to unravel basic mysteries of growth and metabolism of higher plants.

The lemnoids exhibit vegetative propagation as major means of reproduction through formation of clones. This multiplies their utility in genetic research for single clone experiments endowed with prospects of elimination of genetic variability.

The response of lemnoids to various factors like temperature, light, pH of medium and nutrition may be tailored with far more convenience ***in vitro*** cultures than using any other angiosperm as experimental material. There is evidence that effect of 2, 4-D on ***Spirodella polyrhiza*** shows significant retardation in growth and moisture content (Shukla, Pandey and Shukla, 1973). The effect of auxin-photoperiodic inductions on ***S.polyrhiza*** has shown increased growth under higher photoperiods (Shukla and Pandey, 1976). Auxin-photoperiodic inductions have also been found to increase ascorbic acid contents in ***S.polyrhiza*** (Shukla and Pandey, 1972).

Interrelated growth of ***Lemna minor***, ***L. gibba***,

Spirodella sp. and ***Wolffia*** sp. in controlled laboratory conditions were made by Wolke (1974a), and Mathur and Yadav (1975). The study Showed that ***S.polyrhiza***, ***L. gibba***, ***L. minor***, ***Wolffia microscopica*** and ***W. arrhiza*** exhibit gradual decline in growth (Kessler and Steinberg, 1973). There are two kinds of growth patterns exhibited by duckweeds, (i) phytochrome effected growth depending on quality of phytochrome controlled by either red illumination in dark cultures or by substitution of cytokinins or synonyms of cytokinins and (II) growth free of phytochrome under continuous light exposures.

The literature on the effects of growth substances (Kisselbach, 1943; Thimann, 1949; Wort, 1951, 1962; Thimann and Bonner, 1933) and chelates (Burstroom, 1963) has been reviewed in general and the topic on lemnoids has been extensively delt by Hillman (1961a), Ashby (1929), Clark (1930) and Saeger (1930). The historical beginning of duckweed research dates back to Hanstein (1899) followed by Mameli and Pollacci (1940). The method of aseptic culture technique was used by Landolt (1957) and growth measurements were made by Gorham (1941, 1950), Clark (1925), Ashby, Bolas and Henderson (1928), Ashby and Oxley (1935), Pirson and Gollner (1953a, 1953b), Hillman (1954), Landolt (1957).

The concept of generation time and kinetics of growth of lemnoids were studied by Clark (1925) and Mendiola (1919) while growth cycles of Lemnaceae cultures in multiplication rate under constant conditions were observed under both short and long day cycles by Dixon (1938a, 1938b) and White (1936). The annual growth cycle in ***Lemna minor*** was studied by Pirson and Gollner (1953a, 1953b) during winter months formation of turions in ***Spirodella polyrhiza*** was reported by Henssen (1954).

There are also reports of injury by smaller amounts of fuel gas (Saeger, 1933). The effect of growth substances and metal chelaters on frond and flower production in duckweeds has been studied in some detail by Oota (1965, 1969, 1972, 1974, 1975,). Light and dark growth in long day duck weed ***Lemna gibba*** as influenced by kinetin has shown that minute doses of kinetin promote rate of frond multiplication in dark but continuous light has little effect. During winter season many lemnoid species produce over-wintering forms called turions. The turion formation in ***Lemna*** and ***Wolffiella*** has been studied by Pieterse, Bhalla and Sabharwal (1970a) and in ***Wolffia*** by Hegelmaier (1868), Guppy (1894), Jacobs (1947), Hicks (1937) and Landolt (1957). However, little is known about phenomenon of turion formation under influence

of growth substances and chelates on growth and flowering of ***Lemna gibba*** (Pieterse, Bhalla and Sabharwal, 1970b; 1970C). Relatively high doses of growth substances inhibit development of photo-periodically induced flower buds and antagonistically promote frond multiplication. In contrast to higher doses, low doses accelerate the process to enhance flower production (Oota and Tsudzuki, 1971). There are other reports on effects of EDDHA, IAA, GA and kinetin on growth and gibbosity of certain duckweed species. Effect of abcissic acid on growth and metabolism of ***Lemna minor*** was studied by Newton (1974).

The study of many tropical hydrophytes is handicapped by their notorious reluctance to flower when grown in cultures. Many members of taxonomically confused genera such as ***Anubias***, ***Aponogeton***, ***Cryptocoryne***, ***Echinodorus*** and ***Lagenandra***, imported into Europe as aquarium plants, prove difficult to cultivate and often remain unidentified until the rare occassions on which they bloom.

Rarity of flowering, together with profound morphological reduction has also created acute taxonomic problem in the *Lemnaceae*. However, these plants are eminently suitable for laboratory studies of the physiology of flowering for reasons (a) the ease and rapidity with which large clones may be

cultured aseptically on nutrient media under perfectly controlled conditions, and (b) the fact that floral and vegetative primordia may be distinguished easily without elaborate dissection, especially in ***Spirodella*** where they develop at different sites on the thallus. ***In vitro*** flowering has been achieved and intensively studied in two species of ***Lemna*** (Hillman, 1961a; 1961b); and one of ***Wolffia*** (Maheshwari and Chauhan, 1963). In these species the transition from vegetative to reproductive growth involves complex and sensitive photoperiodic responses.

The uniqueness of flowering control and its response to variety of factors is another interesting facet. Induction of flowering in ***Lemna paucicostata*** (Maheshwari and Gupta, 1967; Gupta and Maheshwari, 1969; Kandeler and Huegel, 1973; Kandeler, Huegel and Rottenberg, 1974), ***Spirodella polyrhiza*** (Wolke, 1974b), ***Wolffia microscopica*** (Maheshwari and Seth, 1966). ***Lemna perpusilla*** has been studied from the stand point of flowering control by Esahi (1972) and Takimoto (1973). But intricate process of flowering control needs further study and elucidation.

Obviously close to land plant requirement of floating land plants might be expected to modify least and develop into land plant habit. Aquatic vascular plants luxuriently

inhabit standing and flowing fresh waters in all climatic regions. Bulk of them are rooted but some species have abandoned any attachment to the substrate and float freely in the water ***S.polyrhiza*** has been included under the category of partially submerged and partially arial free floating aquatic angiosperms.

There is record of Cyanophyceae growing in association with lemnoids (Stephanova, 1928; Rao, 1953; Shukla and pandey, 1979). Luxuriant growth of ***S.polyrhiza*** may virtually modify environment and result in low oxygen content interlinked with high organic constituents, especially, organic nitrogen. They are likely to simulate conditions ideal for growth of algae. But there is nothing known about ***S.polyrhiza*** growing in aquatic habitats and their likelihood of supporting growth of algae.

Judging from cursory look into literature it appears that bulk of experimental work on growth and metabolism of aquatic plants centres around duckweeds. Correlative studies on effect of natural light and artificial illumination of growth and metabolism of duckweeds have been made in the past (Shukla and Pandey, 1972, 1979; Pandey, 1979 and Awasthi, 1986).

In addition to fungi and bacteria a number of higher plants have been reported to contain gibberellins (Katznelson, Sirosis and Cole, 1962; Brian, Hemming and Lowe, 1964; Maheshwari and Bhatia, 1966; Jones and Lang, 1968; Pronano and Greene, 1968; and Iwahori, Weaver and Pool, 1968). Gibberellins have also been reported from marine algae (Mowat, 1963; Jones and Lang, 1968; Jennings, 1968 and Jennings and McComb, 1967). Likewise gibberellin-like substance has been reported in extracts of ***Phormidium foveolarum*** (Gupta and Shukla, 1967; Gupta and Agarwal, 1973). Literature also supports existance of gibberellin-like substance in watermelon seeds (Bhalla, 1971). Response of rice crop to pre-soaking seed treatment and spraying with algal extracts in growth, development, yield and protein contents has been reported elsewhere (Gupta and Shukla, 1964; 1967; Shukla and Gupta, 1967; Shukla; 1968; 1975a). Effects of pre-soaking seed treatment and spraying with low concentrations of algal extracts has shown remarkable boost in rice productivity, yield and protein-content under green house conditions (Shukla 1972; 1975a). Field trials conducted to ascertain response of rice to ***Phormidium foveolarum*** and ***P. tenue*** extracts showed considerable increase in growth and development of rice plants (Shukla, 1982). Influence of algal extracts growth

and yield of other crop plants like wheat (Kushwaha and Gupta, 1970a; 1970b; Gupta and Kushwaha, 1972), ***Vigna catzang*** (Gupta and Gupta, 1970; 1973) and ***Phaseolus aureus*** (Gupta and Gupta, 1972) has also been studied. Effect of ***Lemna paucicostata*** extracts on growth, yield, development and chemical composition of barley plants has been reported earlier (Pandey, 1979). Response of rice plants to algal extracts reference to certain plant metabolites and some aspects of plant metabolism have also been studied (Shukla, 1968). The topic on effect of algal growth substances has been reviewed recently (Shukla, 1983).

Likewise, effects of water hyacinth extracts on growth and development of rice plants has been extensively studied (Sircar and Kundu, 1960; Sircar, 1963). Effects of ***Lemna paucicostata*** extracts on growth, yield and composition of barley (Pandey, 1979; Shukla and Agnihotri, 1983), wheat plants (Shukla and Gummundi, 1981) have been reported. Effect of ***Wolffia arrhiza*** extracts on growth, development, yield and chemical composition of wheat plants has also been reported (Awasthi, 1986). Possibilites of ***S.polyrhiza*** extracts to alter growth, development and yield appear promising.

Application of growth regulators has been found to effect protein and free amino acid contents in various plants.

A substantial increase in protein contents following hormone treatments has been reported by Sell, Luecke, Taylor and Hamner (1949); Dunham (1951) and Pande (1954). Treatment of bean (Weller, Leucke, Hamner and Sell, 1950) and potato plants (Payne, Fults and Hay, 1952) with 2, 4-D decreased protein and amino acid contents. Results obtained suggest that percentage of protein can, thus, be regulated by application of suitable hormone.

Pre-soaking seed treatment with algal extracts of ***P. foveolarum*** shows considerable increase in protein contents of rice seeds. Phycohormone application almost doubled protein content in rice (Shukla, 1972; 1983). The protein content of seeds shows maximum increase in 1 percent ether extract suspended in water and 5 percent water extract.

Protein contents in cereals is of pivotal importance. Increase in protein contents in cereals is more than desired to meet problems of malnutrition faced world over and in view of this changes in protein contents of wheat following application of ***S.polyrhiza*** extracts might be of immense significance.

Besides the protein other mineral constituents are singularly known to affect quality of cereals. The mineral matter in flour is not large in quantity but it may have a considerable effect

on the quality and behaviour of the flour. The nature of doughs prepared from wheat flour is considerably influenced by the cations present. The percentage of mineral matter present in a flour usually gives a useful indication of the grade of the flour. The percentage of different elements in wheat and flour fractions is dependent upon the soil. The distribution of the mineral constituents in wheat has been summarized by Beeson (1941) and Booth, Carter, Jones and Moran (1941).

Early work at the Ohio Station by Ames and co-workers indicated that added fertilizers influence the mineral composition of wheat ash. Gericke (1933; 1934) showed that the amount of available nitrogen in the soil influenced the protein content of wheat. He also demonstrated with wheat grown in tank cultures that the chemical composition of the grain varied depending on the state of growth at which mineral nutrients were available to the plants. The ash content of wheats grown in Niphad (Maharashtra) was found to be lower than that of the N.P. wheats grown at New Delhi (Banerjee and Das, 1957).

Fertilizer treatments have been found to influence the mineral composition of wheat (Gupta and Das, 1954; Srivastava, Biswas and Das, 1955). Phosphatic fertilization resulted in a significant increase in total phosphorus in the grains. Application

of superphosphate, either alone or in conjunction with other inorganic fertilizers or green manure, showed a significant increase in all the froms of phosphorus. Farmyard manure application, on the other hand did not show any change in the total and phytin phosphorus, although rape cake which does not increase the total phosphorus, markedly increased the phytin phosphorus. Green manuring along shows a decrease in total phytin and inorganic phosphorus while content of soluble phosphorus remains practically uneffected. Bains (1949) also reported that superphosphate treatment increased the total phosphorus content of wheat. The application of various fertilizers with green manure also produced grains with comparatively high content of calcium and total phosphorus.

But hormonal control of elemental composition of cereals with special reference to response of plant extracts has been very little explored (Shukla, 1983). Influence of ***S.polyrhiza*** to alter quality of elemental constitution of wheat produce appears to be proven with considerable improvement in edible value of wheat.

Despite abundance of literature concerned with anatomy of various plants there is a dearth of literature on influence of growth promoting substances on anatomy of various plant systems. However, works of Torrey (1953), Roberts (1960),

Kennedy and Farrar (1965), Maurya (1983), and Cronshaw and Morey (1965); Morey and Cronshaw (1966) on influence of growth substances with reference to the anatomical structure has been recorded elsewhere. Response of plants to growth substances in extracts of ***Pistia stratiotes*** with reference to anatomy of wheat are on record (Maurya, 1983) and ***Wolffia arrhiza*** to anatomy of wheat (Awasthi, 1986).

Literature excels in excellent experimental work of eminent scientists dealing with aquatic plants, still there are wide gaps in our knowledge to fully exploit. ***S.polyrhiza*** attributes likely to offer solution on an array of botanical quizzes. This interesting perspective has method only a causal arbitrary and partial treatment during the works of various investigators in the past. Nothing is known towards application of ***S.polyrhiza*** extracts with special reference to growth, development and yield of wheat plants, and how its metabolism and morpho-anatomical attributes could be altered for better adaptability of the crop to multiply growth and better quality yield. Hillman (1961) rightly pointed out that "while adequate coverage by all work with a particular group of plants must perforce touch most fields of botanical research, it is impossible to consider each of the problems in its general context, to do so would be to write an encyclopaedia." This brief

synoptical background presented here sufficiently pinpoints existing state of knowledge and suggests areas of research of ***S.polyrhiza*** forming theme of present investigation. Present investigation deals with utilization of ***S.polyrhiza*** plants with special reference to growth, yield, and development and certain plant constituents like nitrogen, protein, phosphorus, potash and morpho-anatomical response of wheat plants and how its metabolism and morpho-anatomical attributes could be altered for better adaptability of the crop to multiply growth and better quality yield. Hillman (1961) rightly pointed out that "while adequate coverage by all work with a particular group of plants must perforce touch most fields of botanical research, it is impossible to consider each of the problems in its general context, to do so would be to write an encyclopaedia". This brief synoptical background presented here sufficiently pinpoints existing state of knowledge and suggests areas of research of ***S.Polyrhiza*** forming theme of present investigation. Present investigation deals with utilization of ***S.Polyrhiza*** plants with special reference to growth, yield, and development and certain plant constituents like nitrogen, protein, phosphorus, potash and morpho-anatomical response of wheat plants.

MATERIAL AND METHOD

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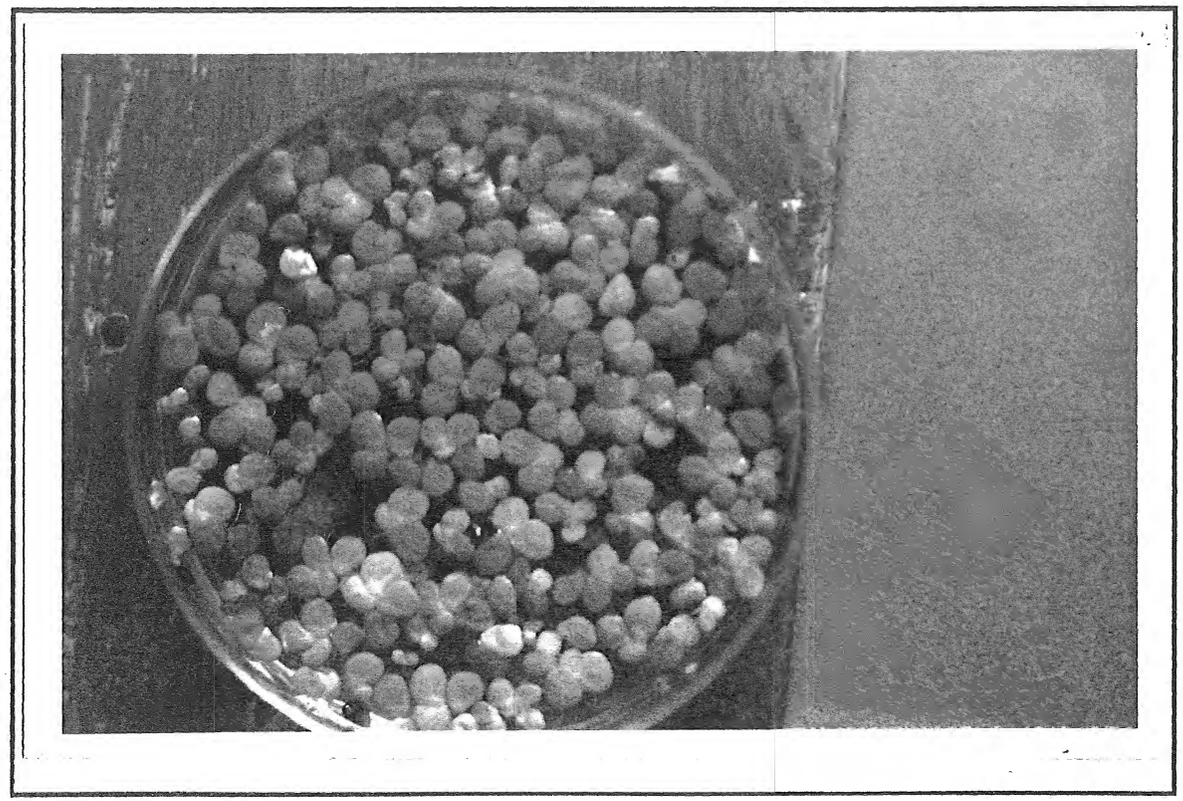
Out of a vast array of hydrophytic plants ***Spirodella polyrhiza*** was particularly chosen as experimental material to study prospects of its utilization in agriculture of wheat, in view of its common small sized hydrophytic plant body and ease of ***in vitro*** culture. ***In vitro*** culture of the plants under exogenous supply of certain growth regulators and varied photoperiodic inductions was studied to obtain healthy material for use in agriculture of wheat.

The experimental material was collected from nature in healthy condition and plants of equal size and shape were carefully selected. Selected plants were vigorously washed in tap water to remove adhering debris and algae. Finally, the material washed with distilled water was cultured in thoroughly acid and distilled water washed rectangular glass containers 2.5'. long, 1' broad and 1.5' deep containing culture media. Media with organic nutrients like sugars, coconut milk and soil extracts were found unsuitable as they either supplemented to the growth of contaminants or bore unknown composition.

PHOTO - 3 : SURFACE VIEW OF PETRI-DISH SHOWING ***IN VITRO*** GROWTH OF ***Spirodella polyrhiza*** FRONDS

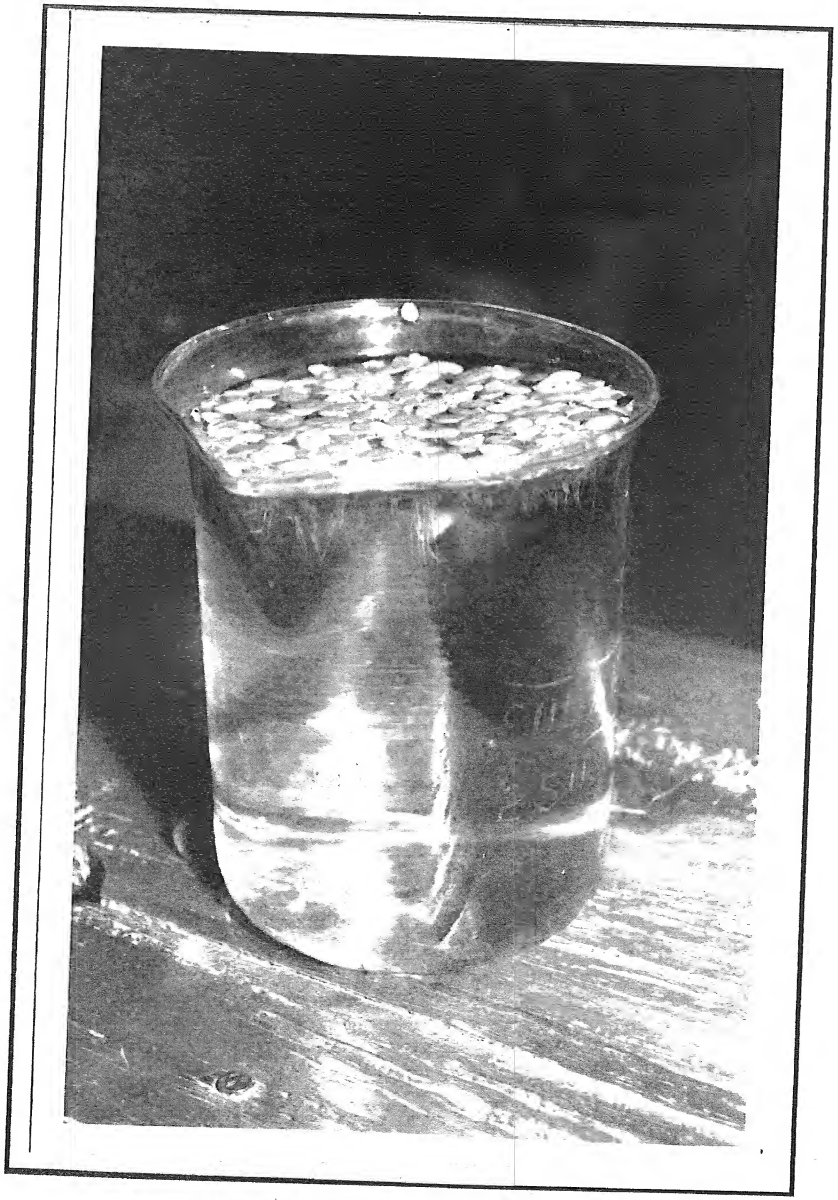


Culture medium as modified and suggested by Pandey (1979) with following composition was selected for bulk use for maintenance of stock culture. The medium was changed fortnightly to avoid exhaustion of nutrients in the medium.

COMPOSITION OF MEDIUM USED IN PRESENT INVESTIGATION

Elemental Constituents	Used as	Strength per litre
K	KNO_3	2 mg.
Ca	$Ca(NO_3)_2$	4 ,,
Mg	$MgSO_4$	2 ,,
P	NaH_2PO_4	2 ,,
S	$MgSO_4$	2 ,,
N	KNO_3 & $Ca(NO_3)_2$	6 ,,
Fe	$Fecl_3$	5.6 ppm
Mn	$MnSO_4$	0.23 ,,
Cu	$CuSO_4$	0.032 ,,
Zn	$ZnSO_4$	0.032 ,,
Mo	Na_2MoO_4	0.025 ,,
B	H_3BO_3	0.185 ,,
Co	$CoSO_4$	0.003 ,,
Ni	$NiSO_4$	0.003 ,,

PHOTO - 4 : LATERAL VIEW OF BEAKER SHOWING ***IN VITRO*** GROWTH OF ***Spirodella polyrhiza*** FRONDS



Side walls of glass containers were covered to the brim of medium with black paper to avoid and minimise algal contamination and curtail light availability of the roots of ***S.polyrhiza*** grown.

In stock cultures, fronds were acclamatised before their use as inoculum in experimental work. The stock cultures were maintained at a temperature of 20 to 28°C with a pH range of 7.0 to 10.5. The cultures were placed in North-South direction near large size glass windows of laboratory and were grown under normal sunlight.

In view to avoid variations caused due to the fact that development of fronds starts long before it becomes visible in culture, especially, in short term growth and metabolic studies, fronds acclimatised for a period of about four weeks were used in a given experiment or series from the same stock and conditions were kept as close as possible to the experiments. Selection and propagation of fronds was based on the fact that despite physiological differences between early and late daughter fronds, the characteristics of a clone can not be altered. The concept of selection of fronds for use as inoculum has been purely based equity in size and shape and not the generation time as it has been considered more apparent than

real and completely misleading.

Studies on utilization of ***S.polyrhiza*** in agriculture were made with special reference to their use for obtaining extracts containing growth substances. Wheat variety "U.P.-2338" was selected to study the effect. Genetically tested seeds were obtained from C.S. Azad University of Agriculture and Technology, Kanpur. Seeds approximately of same size and weight were selected for experiments.

The extractions of ***S.polyrhiza*** were made in water or ether. As ether is injurious to plant growth it was allowed to evaporate and growth promoting substances were suspended in water. Five millilitre of ***S.polyrhiza*** by volume was taken and ground in a clean porcelain mortar with water or ether. In case of water extract sufficient distilled water was added to make it 100 ml to have a five percent extract. 1 and 2 percent extracts were made by further dilutions with distilled water. In case of ether extract ether was first allowed to evaporate and the suspension was then made to 100 ml in distilled water. 1, 2 and 5 percent extracts were made by further dilutions with distilled water. Fifty seeds were soaked in sterilized petri-dishes in different concentrations (1, 2 and 5 percent) of water and ether extracts of ***S.polyrhiza*** and

distilled water (control) for 6, 12 and 24 hours. Desired concentrations used in experiments to study various parameters are specified separately below.

Immediately after the soaking period seedlings were grown in test tubes filled with distilled water on equal sized filter papers following Garrard's technique. The experiments were carried out at a temperature of 20-24°C, the normal temperature range of crop in nature. Observations were made 48, 72 and 96 hours on length of main root, number of secondary roots and length of shoot.

The effect of treatments was studied under field conditions in the garden beds laid for specific purpose with dimensions 8 feet in breadth and 10 feet in length. Each bed was sown with 3 rows containing 9 seeds spaced 25 cm in rows 60 cm apart. Thus, total number of plants grown in each bed were 27 out of which 25 were selected for observations. Two beds of each treatment and normal untreated control were laid to raise 50 replicates. Seeds of wheat variety "U.P.-2338", 1 percent water and 2 percent ether extracts were chosen for observing effects under normal field conditions as out of various concentrations used to study seedling growth, these concentration were found to be beneficial to the maximum

extent and therefore, it was thought to study sustained effect of such treatments on subsequent nature of crop growth, development and yield. Garden beds were prepared after ploughing the area and mixing adequate amount of manure in ratio of 3 parts of soil and 1 part of cowdung manure in upper crust of soil. Seeds soaked in distilled water were similarly sown and served as control. Observations were recorded on vegetative growth with reference to height of plant, number of tillers per plant, number of leaves per plant and average length and breadth of leaves at an interval of 15 days (30, 45, 60, 75, 90 and 105 days) throughout the duration of the crop. Observations on yield were made over number of ears per plant, number of floral branches, ear maturation period and trend of ear setting. The matured crop was harvested after 105 days. Observations on dry weight of straw per plant, dry weight of ears per plant, dry weight of single ear, dry weight of 1000 seeds and percentage ear emergence per day were recorded. Increase in yield of wheat variety "U.P.-2338" was then calculated on the basis of yield in experimental plots. Observations were made on 50 replicates and average results were taken into consideration.

Assay of nitrogen, protein, potash and phosphorus contents in seeds and straw collected from plants after 105

days from treated plants with ***S.polyrhiza*** extracts in concentrations of water and ether extracts applied for 6, 12 and 24 hours pre-soaking treatment and untreated plants were made in replicates of five and average results were taken into consideration.

Nitrogen contents were estimated by usual micro Kjeldahl's procedure. Distillate was collected in 4 percent boric acid, which was titrated by N/10 HCl using mixed indicator of Bromocresol green and Methyl red mixture (5:1). Protein percentages were then calculated by applying protein factor (N x 6.25). Phosphorus contents were estimated by Jackson's (1967) colorimetric method. Potash contents were estimated by percloric acid digestion and cobalt-nitrate method as described by Piper (1950).

Studies on effect of ***S.polyrhiza*** extracts on anatomy of wheat plants variety "U.P.-2338" were made following usual techniques of fixation of desired parts of material and subsequently obtaining its microtomic sections. The sections were dehydrated, stained and observations made as detailed below.

Material of root was cut carefully from both treated (2 percent water and 1 percent ether extracts of ***S.polyrhiza***)

and normal untreated plants serving as control. Observations were made on wheat variety "U.P.-2338" and pre-soaking seed treatments of 6, 12 and 24 hours were applied. Treated plants were grown over filter papers following Garrard's (1954) technique and roots were collected after seedlings obtained 144 hours age. In view to obtain uniform effects of treatments pieces of roots were carefully selected from five cm below root-shoot transition zone. Material of stem was cut carefully from both treatments (2 percent water and 1 percent ether) and control. Pre-soaking seed treatments for 6, 12 and 24 hours were applied. Treated and control plants were grown in garden beds as described earlier. Stem pieces of 2 cm were collected from 5 cm below the top of the plant. Such materials of each treatment were preserved in formalin aceto-alcohol in a mixture containing 90 ml of 70 percent ethyl alcohal, 5 ml glacial acetic acid and 5 ml formalin. The material was then dehydrated and was microtomed using senior Rotary Microtome model MT 1090 A. Slides of materials prepared were stained in safranin and fast green following Johansen's (1940) technique. Observations on diameter of root, diameter of stele, diameter of vascular bundles, number of protoxylem, diameter of metaxylem and number of root hair in root sections, and diameter of stem, number of vascular bundles,

diameter of xylem and phloem and diameter of xylem tissue in stem sections in each treatment were recorded. Results expressed are average of twenty five replicates.

Effect of 6, 12 and 24 hrs pre-soaking seed treatment with 2 percent water and 1 percent ether extracts of ***S.polyrhiza*** on stomatal and epidermal development of wheat seedlings, variety "U.P.-2338" was studied following technique suggested by Shukla (1967). Treated wheat seedlings were allowed to grow for 144 hrs. Second leaf of seedlings from base in different treatment was collected and preserved in alcohol (Lloyd, 1908). The stomatal and epidermal studies were made from peelings of leaves. Both upper and lower epidermal peelings were taken out and stained preparations were observed microscopically. Observation on number of stomata, perimeter of single stomatal opening, number of epidermal cells, length of epidermal cells, breadth of epidermal cells, and length and breadth of guard cells were made in an area of 1984 sqμ of leaf peelings. Average of 25 replicates were taken into consideration.

The data was analysed statistically following analysis of variance method at 5 percent error probability for testing the significance of the effect of treatments. Results of statistical

analysis are entered in respective observation tables.

In view of the wide spread abundance of ***S.polyrhiza*** in various tropical regions of South East Asia in general and India in particular it appears of interest to explore possibilities of utilisation ***S.polyrhiza*** in wheat agriculture. Considering this importance profusely occurring ***S.polyrhiza*** in Banda region it was selected as experimental material for obtaining extracts to study their effect on wheat crop. During the study influence of treatments with extracts of ***S.polyrhiza*** on vegetative growth, development, yield, anatomy and certain constituents of wheat plants as detailed ahead were made.

Forthcoming chapters would deal with correlative growth and metabolism of ***S.polyrhiza*** and suggest probabilities for their utilization in agriculture which may have far reaching academic and applied significance.

CHAPTER 1

STUDIES ON INFLUENCE OF *Spirodella polyrhiza* EXTRACTS ON JUVENILE SEEDLING GROWTH AND DEVELOPMENT OF WHEAT.

STUDIES ON INFLUENCE OF *Spirodella polyrhiza* EXTRACTS ON JUVENILE SEEDLING GROWTH AND DEVELOPMENT OF WHEAT

OBSERVATION ON EFFECT OF ETHER EXTRACT SUSPENDED IN WATER FOR 6 HRS :

INFLUENCE ON LENGTH OF PRIMARY ROOT :

A perusal of Table-1 and Figure-1 shows that various concentrations (1, 2 and 5 percent) of ether extract stimulate length of primary root as compared to control. However, maximum lengths have been witnessed with 1 percent extract and increase in concentrations retards stimulatory effect. The effect of treatment is sustained throughout the duration of observations.

Statistical analysis of data shows that the increase with 1 percent is significant at 5 percent error probability.

TABLE - 1 : EFFECT OF 6 HOURS PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACTS ON JUVENILE SEEDLING GROWTH

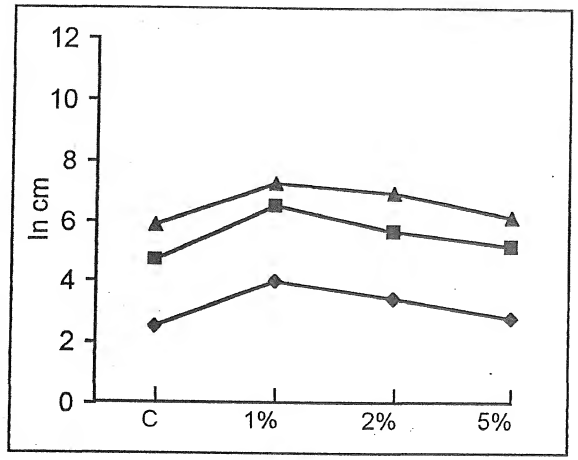
ETHER EXTRACT

AGE OF SEED-LINGS	LENGTH OF PRIMARY ROOT IN CM				N0. OF SECONDARY ROOTS				LENGTH OF PLUMULE IN CM			
	C	1%	2%	5%	C	1%	2%	5%	C	1%	2%	5%
48 HRS	2.56	4.03	3.42	2.81	2.12	3.64	3.01	2.44	1.13	2.06	1.67	1.41
72 HRS	4.73	6.51	5.66	5.20	2.62	4.53	3.86	3.22	3.86	5.75	5.10	4.56
96 HRS	5.85	7.24	6.93	6.11	3.21	5.00	4.74	4.30	5.05	9.38	8.24	7.91
	C.D.= 0.25 DIFFERENCE : 96 HRS 1%-Control = 1.39				C.D. = 0.39 DIFFERENCE : 96 HRS 1%-Control = 1.79				C.D. = 1.55 DIFFERENCE : 96 HRS 1%-Control = 4.33			

ABBREVIATIONS USED : C - Control and C.D.- Critical Difference.

FIGURE - 1 : EFFECT OF 6 HOURS PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACT ON JUVENILE SEEDLING GROWTH

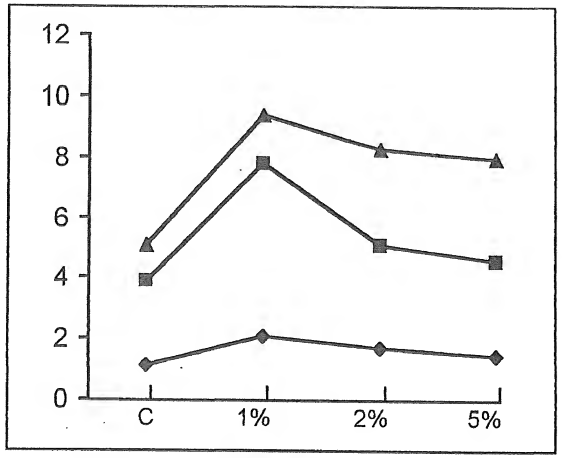
ETHER EXTRACT



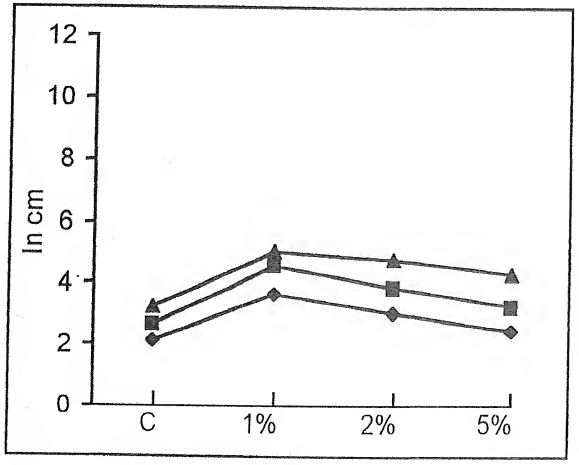
LPR

C - CONTROL
48 HRS
72 HRS
96 HRS

LPR - LENGTH OF PRIMARY ROOT
NSR - NO. OF SECONDARY ROOTS
LP - LENGTH OF PLUMULE

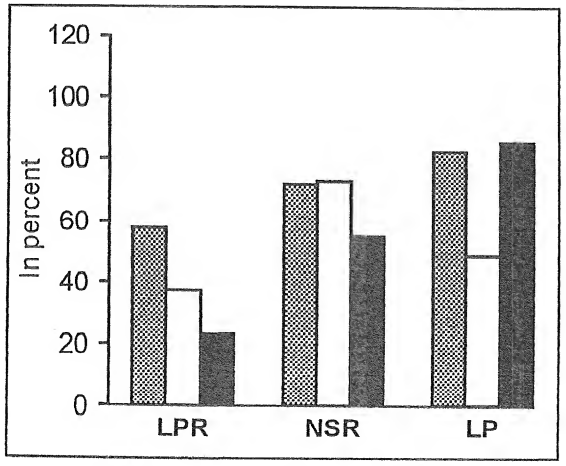


NSR



LP

48 HRS
72 HRS
96 HRS



INFLUENCE ON NUMBER OF SECONDARY ROOTS :

Results given in Table-1 and Figure-1 indicate that number of secondary roots markedly multiplies with 1 percent extract. However, increase in concentration of extracts declines the stimulatory effect. The beneficial effect of treatment is witnessed throughout upto 96 hrs.

Results were statistically analysed following analysis of variance and the data pinpoints that observed increase with 1 percent ether extract in number of secondary roots is significant.

INFLUENCE ON LENGTH OF PLUMULE :

Observations given in Table-1 and Figure-1 show that effect of 1 percent is maximum on length of plumule, increase in concentration retards length of plumule to lesser extent than observed in 1 percent treatment. The beneficial effect is maintained throughout observation period upto 96 hrs.

Statistical analysis of results shows that effect of 1 percent is significant at 5 percent error probability.

OBSERVATIONS ON EFFECT OF WATER EXTRACT FOR 6 HRS :

INFLUENCE ON LENGTH OF PRIMARY ROOT :

Results given in Table-2 and Figure-2 clearly indicate that various concentrations of water extract impart a beneficial effect on length of primary roots. With gradual increase or decrease in concentration of extract applied the stimulatory effect declines. The increase in length of primary root is witnessed throughout the observation upto 96 hrs.

Statistical analysis of results indicates that the effect is significant at 5 percent error probability.

INFLUENCE ON NUMBER OF SECONDARY ROOTS :

Observations recorded in Table-2 and Figure-2 indicate that various concentrations (1, 2 and 5 percent) exhibit a tendency to increase number of secondary roots throughout observations upto 96 hrs. However 2 percent extract exercise maximum increase and gradual promotion in concentrations retards stimulatory effect.

The results were statistically analysed following analysis of variance method and the stimulatory effect of 2 percent extract has been found to be significant at 5 percent error probability.

TABLE - 2 : EFFECT OF 6 HOURS PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON JUVENILE SEEDLING GROWTH

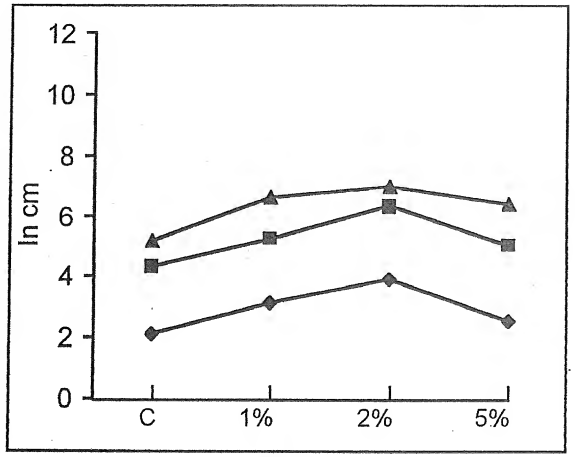
WATER EXTRACT

AGE OF SEED-LINGS	LENGTH OF PRIMARY ROOT IN CM				NO. OF SECONDARY ROOTS				LENGTH OF PLUMULE IN CM			
	C	1%	2%	5%	C	1%	2%	5%	C	1%	2%	5%
48 HRS	2.12	3.10	3.91	2.52	2.04	2.58	3.41	2.13	1.09	1.35	2.10	1.14
72 HRS	4.31	5.24	6.33	5.03	2.51	2.92	4.10	2.32	3.85	5.68	6.23	4.61
96 HRS	5.20	6.62	7.00	6.38	2.98	3.48	4.89	3.17	4.94	8.12	9.37	6.91
	C.D.=0.58 DIFFERENCE : 96 HRS 2%-Control =1.80				C.D. =0.31 DIFFERENCE : 96 HRS 2%-Control =1.91				C.D. =1.53 DIFFERENCE : 96 HRS 2%-Control =4.43			

ABBREVIATIONS USED : C - Control and C.D.- Critical Difference.

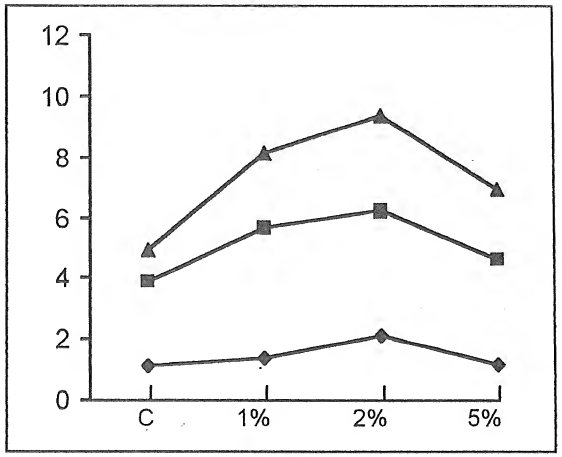
FIGURE - 2 : EFFECT OF 6 HOURS PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACT ON JUVENILE SEEDLING GROWTH

WATER EXTRACT



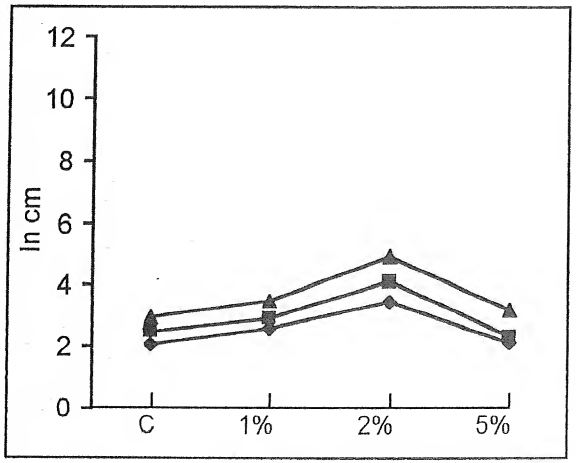
LPR

C - CONTROL
48 HRS
72 HRS
96 HRS



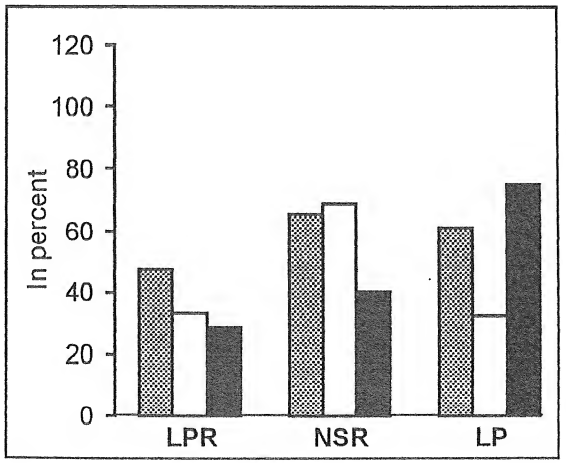
NSR

LPR - LENGTH OF PRIMARY ROOT
NSR - NO. OF SECONDARY ROOTS
LP - LENGTH OF PLUMULE



LP

48 HRS
72 HRS
96 HRS



INFLUENCE ON LENGTH OF PLUMULE :

Results given in Table-2 and Figure-2 are indicative that treatment with different concentrations (1, 2 and 5 percent) impart an increase in length of plumule throughout observations upto 96 hrs. Two percent extract is maximum in effectiveness and increase in concentration of extract gradually retards stimulatory effect of treatment.

Statistical analysis of data shows that observed increase with 2 percent treatment is significant at 5 percent error probability.

OBSERVATIONS ON EFFECT OF ETHER EXTRACT SUSPENDED IN WATER FOR 12 HRS :

INFLUENCE ON LENGTH OF PRIMARY ROOT :

Results given in Table-3 and Figure-3 clearly indicate that various concentrations of ether extract exercise a beneficial effect on length of primary roots with gradual increase in concentration of extract applied, the stimulatory effect declines. The increase in length of primary root is observed throughout the observations upto 96 hrs.

Statistical analysis of results suggests that the effect is significant at 5 percent error probability.

TABLE - 3 : EFFECT OF 12 HOURS PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACTS ON JUVENILE SEEDLING GROWTH

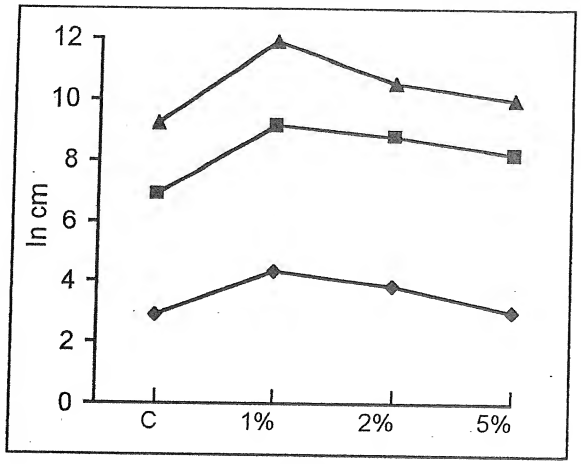
ETHER EXTRACT

AGE OF SEED-LINGS	LENGTH OF PRIMARY ROOT IN CM				N0. OF SECONDARY ROOTS				LENGTH OF PLUMULE IN CM			
	C	1%	2%	5%	C	1%	2%	5%	C	1%	2%	5%
48 HRS	2.93	4.33	3.86	3.02	2.24	3.71	3.18	2.58	1.45	2.34	2.00	1.76
72 HRS	6.86	9.15	8.75	8.21	2.86	4.83	3.91	3.42	5.81	7.71	6.12	5.84
96 HRS	9.22	11.91	10.53	9.98	3.64	5.13	4.00	3.79	6.03	10.56	8.93	8.06
	C.D.=0.74 DIFFERENCE : 96 HRS 1%-Control =2.69				C.D. =0.37 DIFFERENCE : 96HRS 1%-Control =1.49				C.D. =1.67 DIFFERENCE : 96 HRS 1%-Control =4.53			

ABBREVIATIONS USED : C - Control and C.D.- Critical Difference.

FIGURE - 3 : EFFECT OF 12 HOURS PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACT ON JUVENILE SEEDLING GROWTH

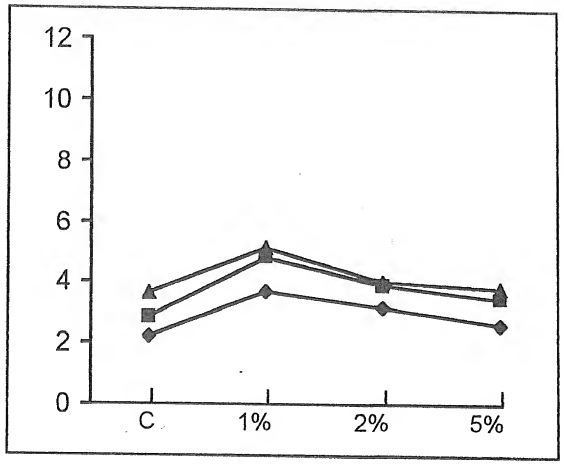
ETHER EXTRACT



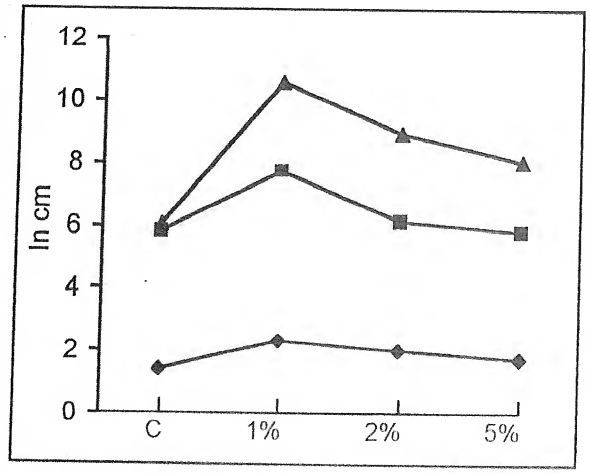
LPR

C - CONTROL
48 HRS
72 HRS
96 HRS

LPR - LENGTH OF PRIMARY ROOT
NSR - NO. OF SECONDARY ROOTS
LP - LENGTH OF PLUMULE

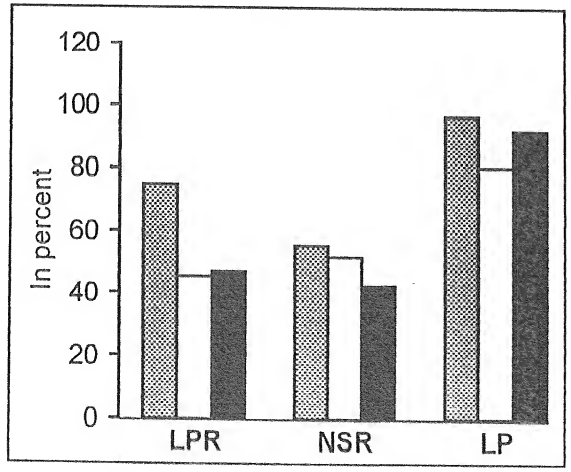


NSR



LP

48 HRS
72 HRS
96 HRS



INFLUENCE ON NUMBER OF SECONDARY ROOTS :

Observations recorded in Table-3 and Figure-3 indicate that various concentrations (1, 2 and 5 percent) exhibit a tendency to increase number of secondary roots throughout observations upto 96 hrs. However 1 percent extract exercise maximum promotion and gradual increase in concentration declines stimulatory effect.

The results were statistically analysed following analysis of variance method and the beneficial effect of 1 percent extract has been found to be significant at 5 percent error probability.

INFLUENCE ON LENGTH OF PLUMULE :

Results given in Table-3 and Figure-3 are indicative that treatment with different concentrations (1, 2 and 5 percent) implement an increase in length of plumule throughout observations upto 96 hrs. 1 percent extract is maximum in effectiveness and increase in concentration of extract gradually declines stimulatory effect of treatment.

Statistical analysis of data shows that observed increase with 1 percent treatment is significant at 5 percent error probibility.

OBSERVATIONS ON EFFECT OF WATER EXTRACT FOR 12 HRS :

INFLUENCE ON LENGTH OF PRIMARY ROOT :

Results given in Table-4 and Figure-4 suggest that 1 percent treatment has a beneficial influence on primary root. While gradual increase in concentrations decreases stimulatory effect over control. 5 percent extract retards length of primary root over control at 96 hrs only.

Results were statistically analysed following analysis of variance method and have been found to be significant at 5 percent error probability.

INFLUENCE ON NUMBER OF SECONDARY ROOTS :

Observations recorded in Table-4 and Figure-4 indicate that various concentrations (1, 2 and 5 percent) exhibit a tendency to increase number of secondary roots throughout observations upto 96 hrs. However, 1 percent extract exercise maximum effect and gradual increase in concentration retards stimulatory effect.

The results were statistically analysed following analysis of variance method and the beneficial effect of 1 percent extract has been found to be significant at 5 percent error probability.

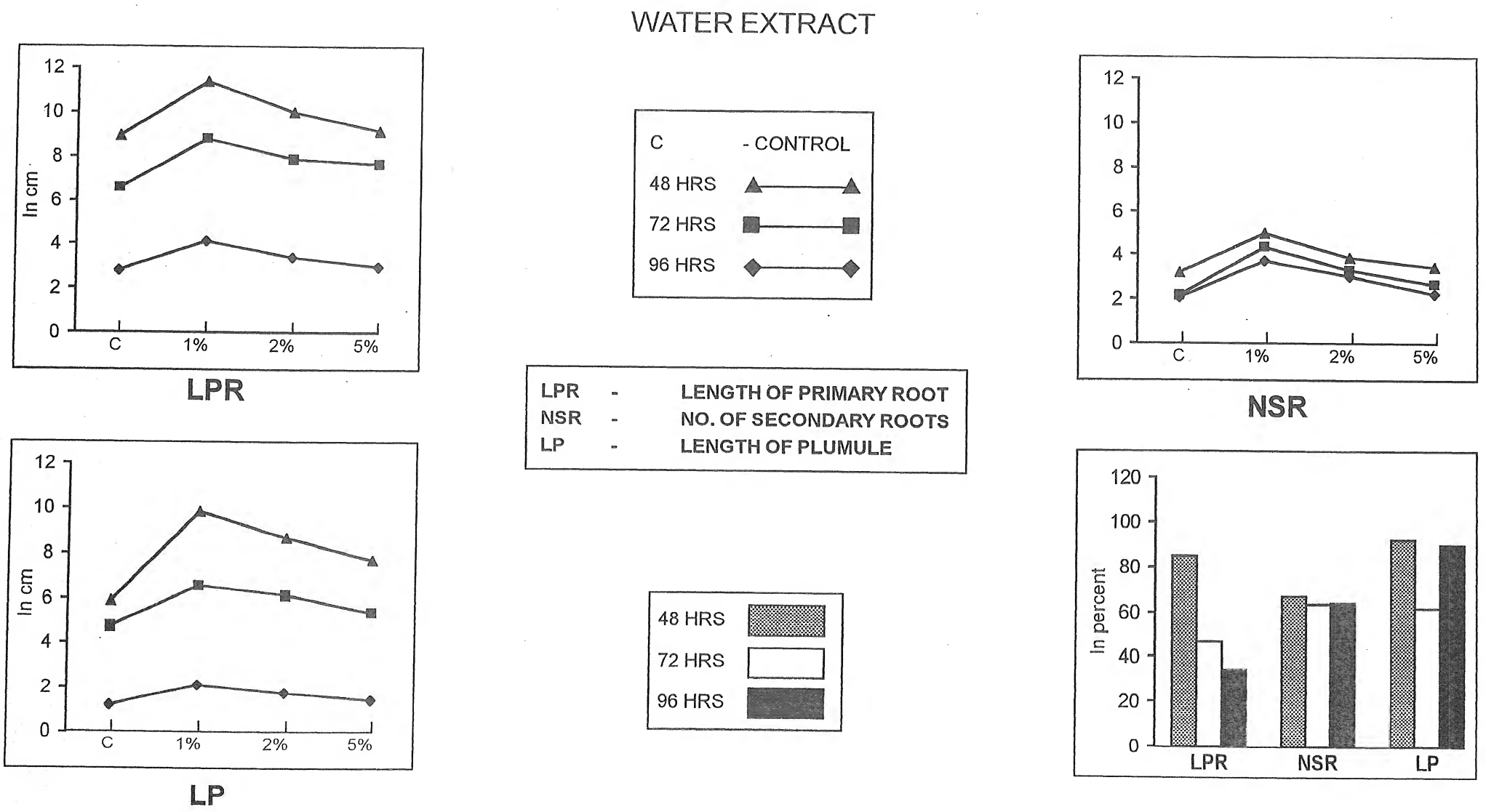
TABLE - 4 : EFFECT OF 12 HOURS PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACTS ON JUVENILE SEEDLING GROWTH

WATER EXTRACT

AGE OF SEED-LINGS	LENGTH OF PRIMARY ROOT IN CM				NO. OF SECONDARY ROOTS				LENGTH OF PLUMULE IN CM			
	C	1%	2%	5%	C	1%	2%	5%	C	1%	2%	5%
48 HRS	2.81	4.12	3.40	2.94	2.07	3.70	3.00	2.21	1.23	2.12	1.76	1.42
72 HRS	6.53	8.78	7.87	7.65	2.15	4.35	3.28	2.66	4.74	6.56	6.11	5.33
96 HRS	8.95	11.36	10.00	9.14	3.19	4.96	3.84	3.43	5.88	9.84	8.65	7.69
	C.D.=0.68 DIFFERENCE : 96 HRS 1%-Control =2.41				C.D. =0.31 DIFFERENCE : 96 HRS 1%-Control =1.77				C.D. =1.33 DIFFERENCE : 96 HRS 1%-Control =3.96			

ABBREVIATIONS USED : C - Control and C.D.- Critical Difference.

FIGURE - 4 : EFFECT OF 12 HOURS PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACT ON JUVENILE SEEDLING GROWTH



INFLUENCE ON LENGTH OF PLUMULE :

Results given in Table-4 and Figure-4 are indicative that treatment with different concentrations (1, 2 and 5 percent) exercise an increase in length of plumule throughout observations upto 96 hrs. One percent is maximum in effectiveness and increase in concentration of extract gradually retards stimulatory effect of treatment.

Statistical analysis of data shows that observed increase with 1 percent treatment is significant at 5 percent error probability.

OBSERVATIONS ON EFFECT OF ETHER EXTRACT SUSPENDED IN WATER FOR 24 HRS :

INFLUENCE ON LENGTH OF PRIMARY ROOT :

Results given in Table-5 and Figure-5 clearly indicate that various concentrations of ether extract exhibit a beneficial effect on length of primary roots. With gradual increase in concentration of extract applied the stimulatory effect declines. The increase in length of primary root is exercised throughout the observations upto 96 hrs.

Statistical analysis of results suggests that the effect is significant at 5 percent error probability.

TABLE - 5 : EFFECT OF 24 HOURS PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACTS ON JUVENILE SEEDLING GROWTH

ETHER EXTRACT

AGE OF SEED-LINGS	LENGTH OF PRIMARY ROOT IN CM				NO. OF SECONDARY ROOTS				LENGTH OF PLUMULE IN CM			
	C	1%	2%	5%	C	1%	2%	5%	C	1%	2%	5%
48 HRS	2.05	3.58	2.21	2.10	2.11	3.28	2.46	2.21	1.00	1.97	1.56	1.18
72 HRS	4.12	6.00	5.48	5.03	2.38	3.61	2.84	2.53	2.63	4.74	3.82	3.03
96 HRS	4.88	7.17	6.31	5.96	2.91	4.16	3.78	3.40	4.20	8.06	7.92	7.34

C.D.=0.64
DIFFERENCE : 96 HRS
1%-Control =2.29

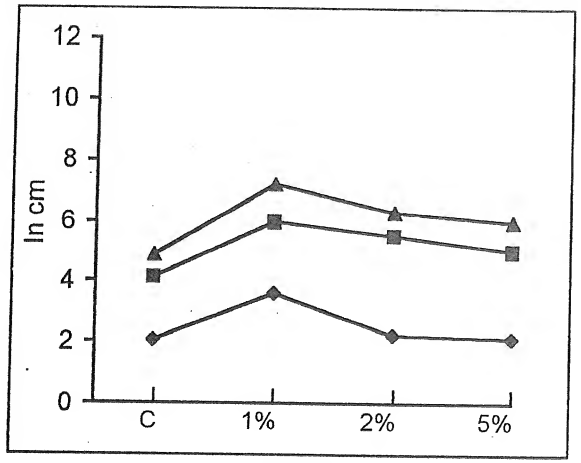
C.D. =0.27
DIFFERENCE : 96 HRS
1%-Control =1.25

C.D. =1.65
DIFFERENCE : 96 HRS
1%-Control =3.86

ABBREVIATIONS USED : C - Control and C.D.- Critical Difference.

FIGURE - 5 : EFFECT OF 24 HOURS PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACT ON JUVENILE SEEDLING GROWTH

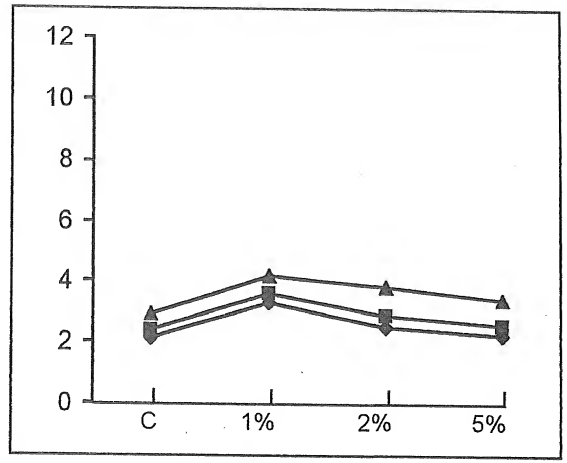
ETHER EXTRACT



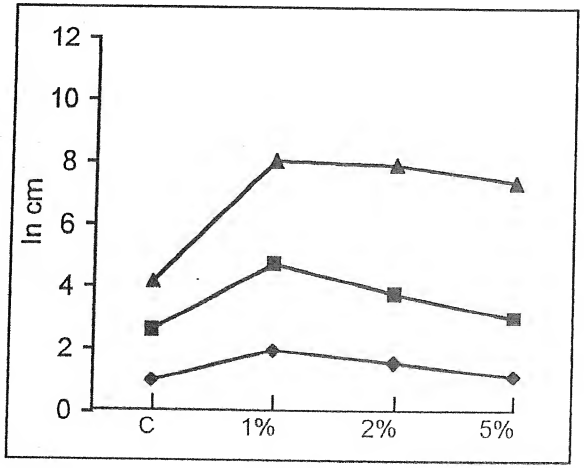
LPR

C - CONTROL
48 HRS
72 HRS
96 HRS

LPR - LENGTH OF PRIMARY ROOT
NSR - NO. OF SECONDARY ROOTS
LP - LENGTH OF PLUMULE

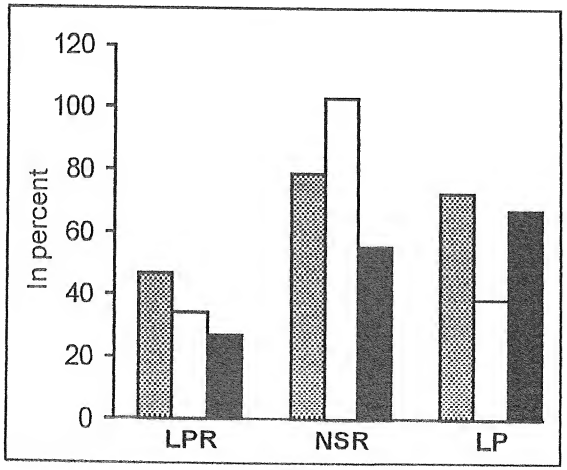


NSR



LP

48 HRS
72 HRS
96 HRS



INFLUENCE ON NUMBER OF SECONDARY ROOTS :

Observations recorded in Table-5 and Figure-5 indicate that various concentrations (1, 2 and 5 percent) exhibit a tendency to increase number of secondary roots throughout observations upto 96 hrs. However, 1 percent extract exercise maximum effect and gradual increase in concentration retards stimulatory effect.

The results were statistically analysed following analysis of variance method and the beneficial effect of 1 percent extract has been found to be significant at 5 percent error probability.

INFLUENCE ON LENGTH OF PLUMULE :

Results given in Table-5 and Figure-5 are indicative that treatment with different concentrations (1, 2 and 5 percent) impart an increase in length of plumule throughout observations upto 96 hrs. One percent extract is maximum in effectiveness and increase in concentration of extract gradually declines stimulatory effect of treatment.

Statistical analysis of data shows that observed increase with 1 percent treatment is significant at 5 percent error probability.

OBSERVATIONS ON EFFECT OF WATER EXTRACT FOR 24 HRS :

INFLUENCE ON LENGTH OF PRIMARY ROOT :

Results given in Table-6 and Figure-6 suggest that 1 percent treatment has a beneficial influence on length of primary root. While gradual increase in concentrations decreases stimulatory effect over control 5 percent extract retards length of primary root over control at 96 hrs only.

Results were statistically analysed folliwng analysis of variance method and have been found to be significant at 5 percent error probability.

INFLUENCE ON NUMBER OF SECONDARY ROOTS :

Observations recorded in Table-6 and Figure-6 indicate that various concentrations (1, 2 and 5 percent) exhibit a constant tendency to increase number of secondary roots throughout observations upto 96 hrs. However, 1 percent extract exercise maximum effect and gradual increase in concentration retards stimulatory effect.

The results were statistically analysed following analysis of variance method and the beneficial effect of 1 percent extract has been found to be significant at 5 percent error probability.

TABLE - 6 : EFFECT OF 24 HOURS PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACTS ON JUVENILE SEEDLING GROWTH

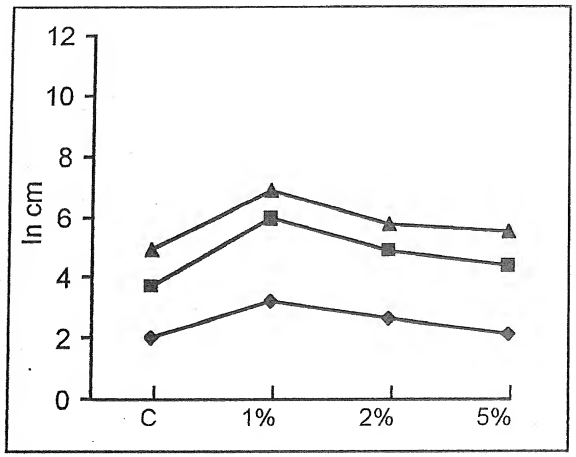
WATER EXTRACT

AGE OF SEED-LINGS	LENGTH OF PRIMARY ROOT IN CM				NO. OF SECONDARY ROOTS				LENGTH OF PLUMULE IN CM			
	C	1%	2%	5%	C	1%	2%	5%	C	1%	2%	5%
48 HRS	2.00	3.23	2.64	2.14	1.91	3.11	2.18	2.06	0.96	2.01	1.11	1.00
72 HRS	3.71	5.97	4.88	4.38	2.13	3.96	2.63	2.17	3.13	5.84	4.93	4.14
96 HRS	4.90	6.85	5.76	5.51	2.82	4.53	3.00	2.88	4.57	9.00	7.69	6.30
	C.D.=0.45 Differene :96 HRS 1%-Control =1.95				C.D. =0.38 Difference :96 HRS 1%-Control =1.71				C.D. =1.52 Difference :96 HRS 1%-Control =4.43			

ABBREVIATIONS USED : C - Control and C.D.- Critical Difference.

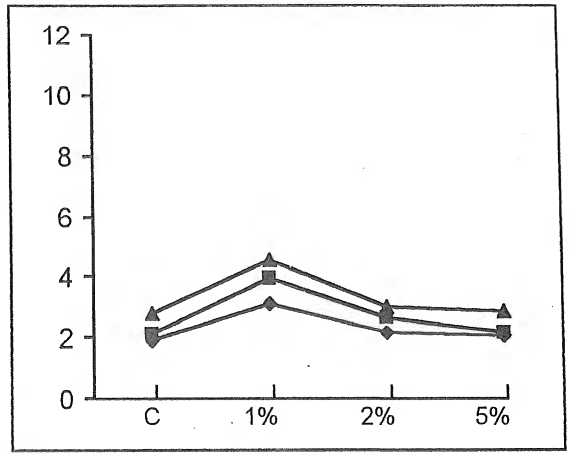
FIGURE - 6 : EFFECT OF 24 HOURS PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACT ON JUVENILE SEEDLING GROWTH

WATER EXTRACT



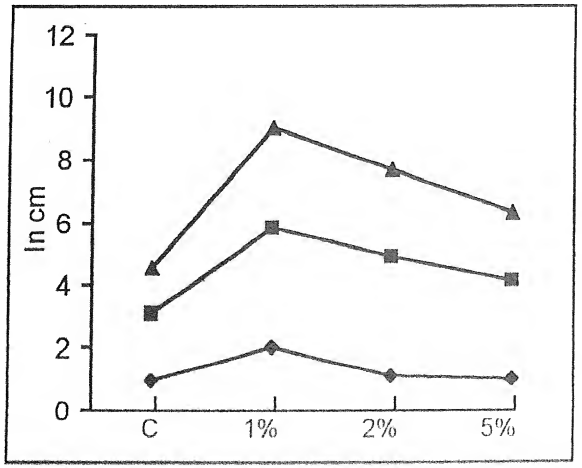
LPR

C - CONTROL
48 HRS
72 HRS
96 HRS



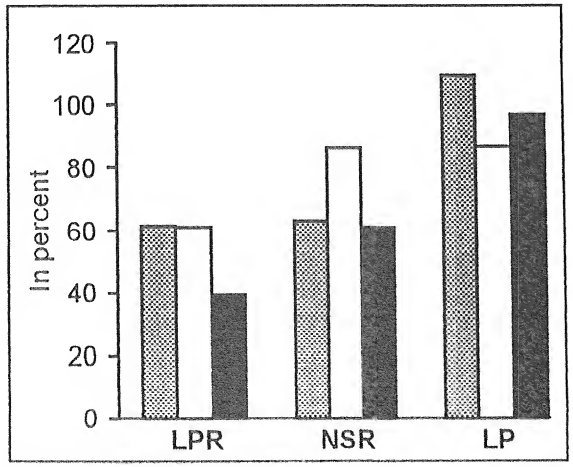
NSR

LPR - LENGTH OF PRIMARY ROOT
NSR - NO. OF SECONDARY ROOTS
LP - LENGTH OF PLUMULE



LP

48 HRS
72 HRS
96 HRS



INFLUENCE ON LENGTH OF PLUMULE :

Results given in Table-6 and Figure-6 are indicative that treatment with different concentrations (1, 2 and 5 percent) exercise an increase in length of plumule throughout observations upto 96 hrs. 1 percent is maximum in effectiveness and increase in concentration of extract gradually retards stimulatory effect of treatment.

Statistical analysis of data shows that observed increase with 1 percent treatment is significant at 5 percent error probability.

CHAPTER 2

STUDIES ON EFFECT OF *Spirodella polyrhiza* EXTRACTS ON GROWTH, DEVELOPMENT AND YIELD OF WHEAT.

PHOTO - 5 : SHOWING EFFECT OF VARIOUS TREATMENTS WITH EXTRACTS OF ***Spirodella polyrhiza*** PLANTS ON WHEAT CROP

STUDIES ON EFFECT OF *Spirodella polyrhiza* EXTRACTS ON GROWTH, DEVELOPMENT AND YIELD OF WHEAT

EFFECT OF 6 HRS ETHER AND WATER EXTRACTS ON VEGETATIVE GROWTH :

INFLUENCE ON HEIGHT OF PLANTS :

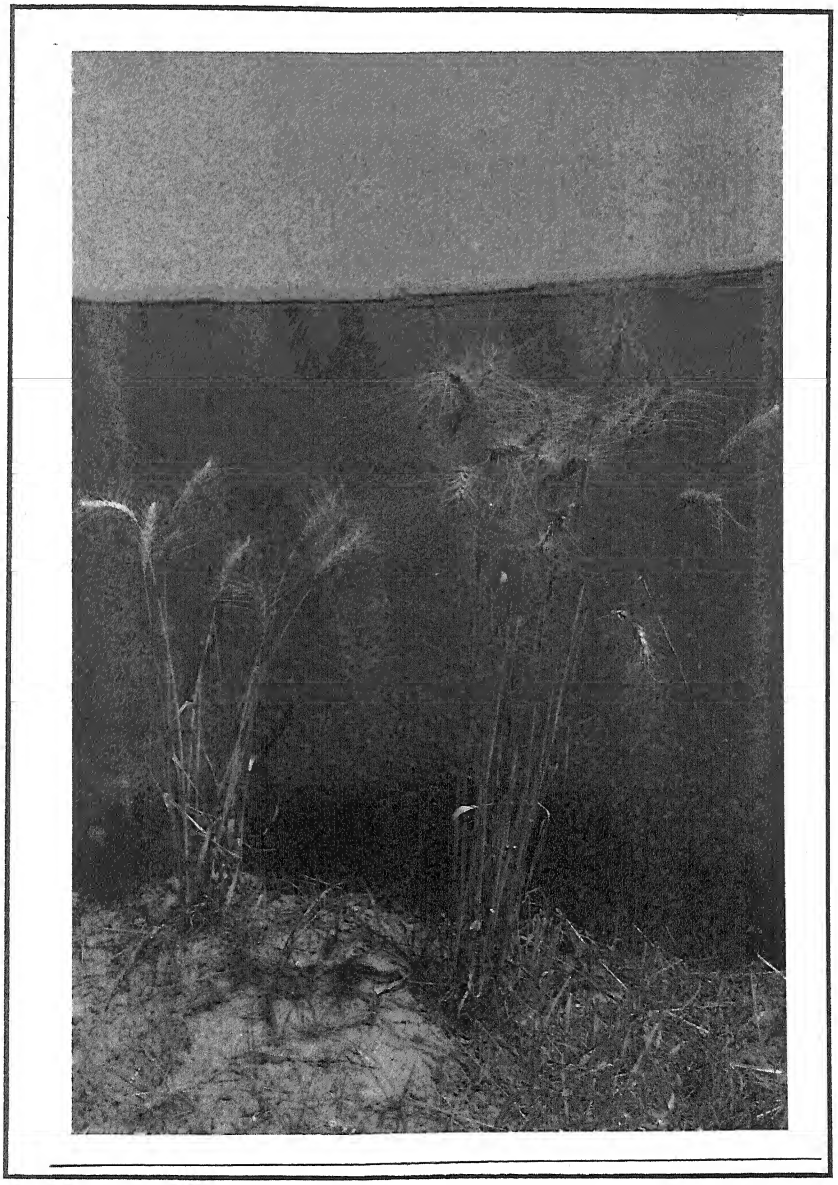
An examination of Table-7 and Figure-7 shows stimulatory effect of 1 percent ether and 2 percent water extracts. The beneficial effect is observed throughout the duration of the crop. Comparatively 1 percent ether extract promotes height of the plants to a greater extent than 2 percent water extract.

Statistical analysis of the data, however, suggests that observed effect is significant at 5 percent error probability.

INFLUENCE ON NUMBER OF TILLERS PER PLANT :

A perusal of results given in Table-7 and Figure-7 shows beneficial effect of 1 percent ether and 2 percent water

PHOTO - 6 : SHOWING EFFECT OF 6 HOURS PRE-SOAKING TREAT WITH EXTRACTS OF ***Spirodella polyrhiza*** PLANTS ON GR AND YIELD OF WHEAT PLANTS



CONTROL

1 PERCENT
ETHER - WATER EXTRACT

extracts. The stimulatory effect is observed throughout the duration of the crop. Comparatively 1 percent ether extract promotes number of tillers per plant to a greater extent than 2 percent water extract.

Statistical analysis of the data, suggests that observed effect with 1 percent ether extract is significant at 5 percent error probability.

INFLUENCE ON NUMBER OF LEAVES PER PLANT :

Results given in Table-7 and Figure-7 show stimulatory effect of 1 percent ether and 2 percent water extracts. The beneficial effect is observed throughout the duration of the crop. Comparatively 1 percent ether extract promotes number of leaves to the greater extent than 2 percent water extract.

Statistical analysis of the data, however, suggests that observed effect is significant at 5 percent error probability.

INFLUENCE ON LENGTH OF LEAVES :

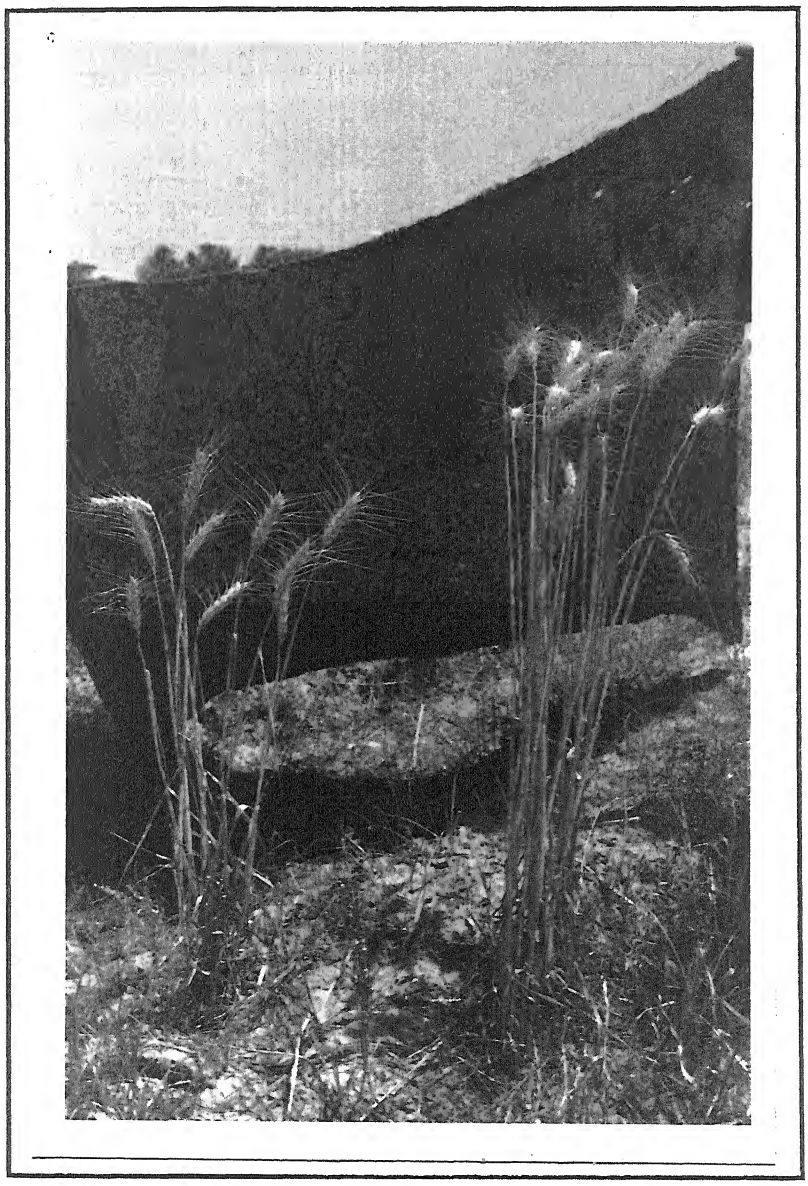
Observations entered in Table-7 and Figure-7 show beneficial effect of 1 percent ether and 1 percent water extracts. The stimulatory effect is observed throughout the duration of the crop. Comparatively 1 percent ether extract promotes length of leaves to a greater extent than 2 percent water extract.

TABLE - 7 : EFFECT OF 6 HOURS PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACTS ON VEGETATIVE GROWTH OF WHEAT PLANTS

DAYS	HEIGHT OF PLANTS IN CM			NO. OF TILLERS PER PLANT			NO. OF LEAVES PER PLANT			LENGTH OF LEAVES IN CM			BREADTH OF LEAVES IN CM		
	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W
30	25.19	31.68	29.45	0.00	0.00	0.00	9.13	15.35	11.31	12.23	17.76	15.53	0.97	1.26	1.03
45	43.21	58.13	51.36	6.36	13.05	9.19	29.53	48.75	40.15	23.27	27.50	24.03	1.31	2.04	1.85
60	71.53	83.44	76.23	9.53	17.75	12.06	49.16	65.37	58.08	27.97	33.18	28.77	1.81	2.71	2.34
75	82.36	90.71	86.68	14.88	20.13	16.83	60.12	87.30	71.47	30.87	35.56	32.67	2.45	3.62	3.02
90	85.81	92.15	91.03	15.65	22.14	19.31	74.00	102.31	88.93	31.81	37.90	34.18	2.76	3.87	3.04
105	86.11	93.34	91.54	16.72	23.35	20.11	74.37	102.91	90.15	32.13	38.21	34.94	3.11	3.95	3.43
	C.D. = 3.40 DIFFERENCE : 1% EW-C = 7.23 DIFFERENCE : 2% W-C = 5.43			C.D. = 4.53 DIFFERENCE : 1% EW-C = 6.63 DIFFERENCE : 2%W-C = 3.39			C.D. = 8.20 DIFFERENCE : 1% EW-C = 28.54 DIFFERENCE : 2%W-C = 15.78			C.D. = 1.10 DIFFERENCE : 1% EW-C = 6.08 DIFFERENCE : 2%W-C = 2.81			C.D. = 0.33 DIFFERENCE : 1% EW-C = 0.84 DIFFERENCE : 2%W-C = 0.32		

ABBREVIATIONS USED : C- Control, EW- Ether-Water extract, W- Water extract and C.D.- Critical Difference.

PHOTO - 7 : SHOWING EFFECT OF 12 HOURS PRE-SOAKING TREATMENT WITH EXTRACTS OF ***Spirodella polyrhiza*** PLANTS ON GROWTH AND YIELD OF WHEAT PLANTS



CONTROL

1 PERCENT
ETHER - WATER EXTRACT

Results were statistically analysed following analysis of variance method and observed increase with 1 percent ether extract are significant.

INFLUENCE ON NUMBER OF TILLERS PER PLANT :

Observations given in Table-8 and Figure-8 exhibit that number of tillers increases under treatments with both 1 percent ether and water extract. Effect of ether extract is comparatively more effective than water extract. However, the stimulatory effect of treatments are maintained throughout the duration of the observations.

Results were statistically analysed following analysis of variance method and observed increase are significant.

INFLUENCE ON NUMBER OF LEAVES PER PLANT :

Observations entered in Table-8 and Figure-8 show that number of leaves slightly increases under treatments with both 1 percent ether and water extracts. Effect of ether extract is comparatively more marked than water extract. However, the beneficial effect of treatments are sustained throughout the duration of the crop.

Results were statistically analysed following analysis of variance method and observed increase are significant.

INFLUENCE ON LENGTH OF LEAVES :

A perusal of Table-8 and Figure-8 exhibits that length of leaves increases under treatments with both 1 percent ether and water extracts. Effect of ether extract is comparatively more marked than water extract. However, the stimulatory effect of treatments are maintained throughout the duration of observations.

Results were statistically analysed following analysis of variance method and observed increase are significant.

INFLUENCE ON BREADTH OF LEAVES :

An examination of Table-8 and Figure-8 shows that breadth of leaves increased under treatment with both 1 percent ether and water extracts. Effect of ether extract is comparatively more pronounced than water extract. However, beneficial effect of treatments are maintained throughout the duration of the crop.

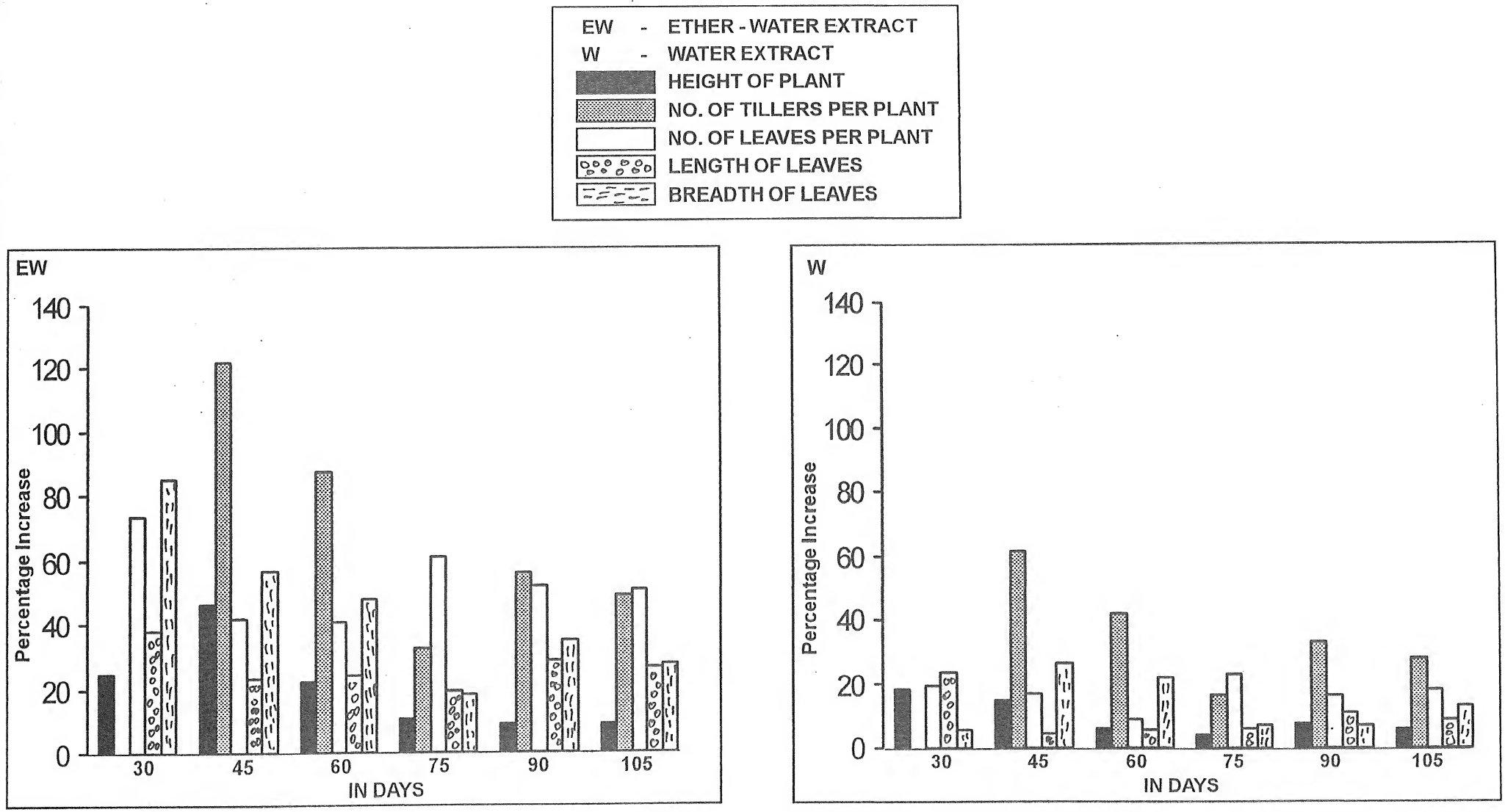
Results were statistically analysed following analysis of variance method and observed increase are significant.

TABLE - 8 : EFFECT OF 12 HOURS PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACTS ON VEGETATIVE GROWTH OF WHEAT PLANTS

DAYS	HEIGHT OF PLANTS IN CM			NO. OF TILLERS PER PLANT			NO. OF LEAVES PER PLANT			LENGTH OF LEAVES IN CM			BREADTH OF LEAVES IN CM		
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W
30	28.31	35.36	33.49	0.00	0.01	0.00	10.16	17.62	12.11	14.20	19.49	17.59	1.06	1.96	1.12
45	45.41	66.31	52.15	7.31	16.21	11.80	36.10	51.19	42.28	25.71	31.70	26.80	1.38	2.16	1.74
60	73.53	89.67	78.06	10.28	19.24	14.57	56.24	79.22	61.13	28.08	34.81	29.57	1.93	2.85	2.35
75	84.57	93.35	87.59	15.97	21.13	18.59	61.63	99.35	75.93	31.12	37.04	33.01	2.72	3.22	2.92
90	88.50	96.38	95.19	15.86	24.78	21.06	78.16	118.47	91.18	31.95	41.02	35.41	2.91	3.91	3.11
105	91.06	98.91	96.43	17.03	25.35	21.81	79.15	119.10	93.51	32.86	41.51	35.75	3.12	3.98	3.53
	C.D. = 5.98 DIFFERENCE : 1% EW-C = 7.85 DIFFERENCE : 1% W-C = 5.37			C.D. = 3.29 DIFFERENCE : 1% EW-C = 8.32 DIFFERENCE : 1%W-C = 4.78			C.D. = 13.11 DIFFERENCE : 1% EW-C = 39.95 DIFFERENCE : 1%W-C = 14.36			C.D. = 1.75 DIFFERENCE : 1% EW-C = 8.65 DIFFERENCE : 1%W-C = 2.89			C.D. = 0.23 DIFFERENCE : 1% EW-C = 0.86 DIFFERENCE : 1%W-C = 0.41		

ABBREVIATIONS USED : C- Control, EW- Ether-Water extract, W- Water extract and C.D.- Critical Difference.

FIGURE - 8 : EFFECT OF 12 HOURS PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACT ON VEGETATIVE GROWTH OF WHEAT PLANT



EFFECT OF 24 HRS ETHER AND WATER EXTRACTS ON VEGETATIVE GROWTH :

INFLUENCE ON HEIGHT OF PLANTS :

Results given in Table-9 and Figure-9 exhibit that height of plants slightly increase under treatments with both 1 percent ether and water extracts. Effect of ether extract is comparatively more effective than water extract. However, the beneficial effect of treatment are sustained throughout the duration of the crop.

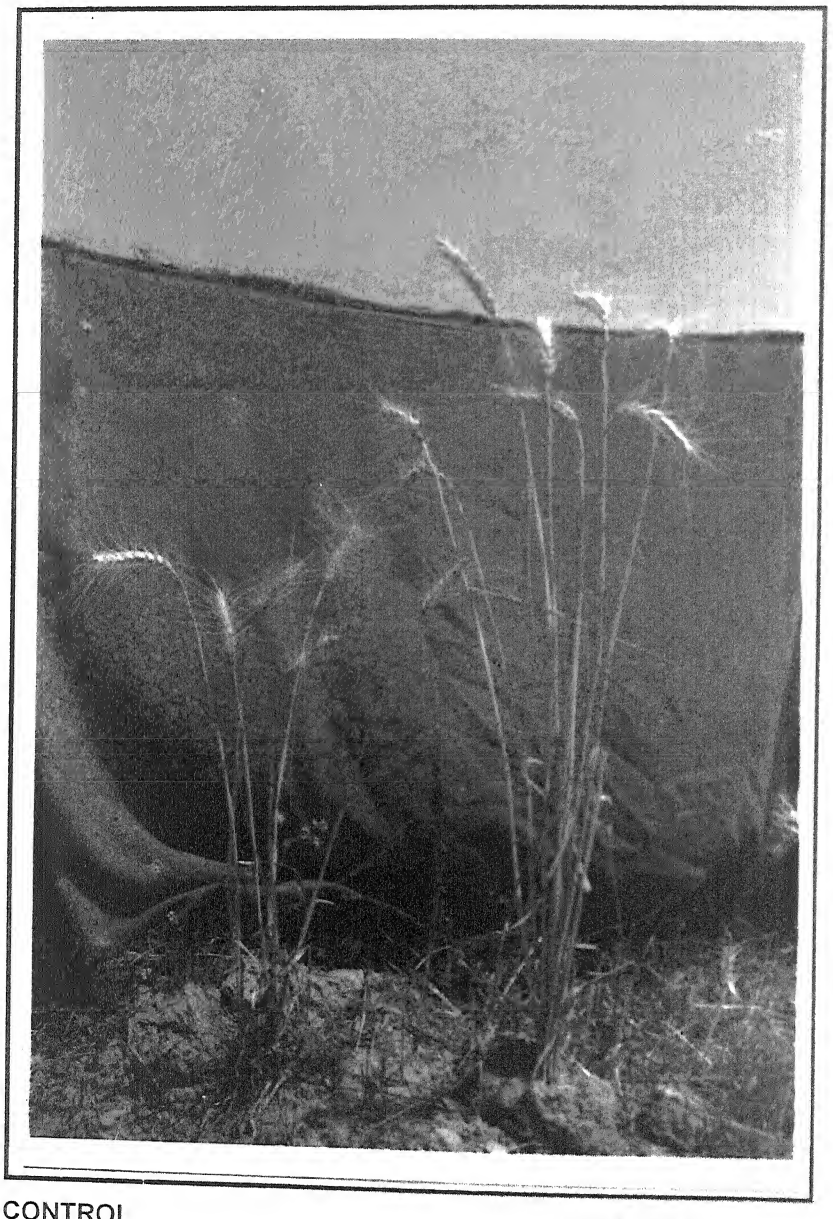
Results were statistically analysed following analysis of variance method and observed increase is significant.

INFLUENCE ON NUMBER OF TILLERS PER PLANT :

Observations given in Table-9 and Figure-9 show that number of tillers increases under treatments with both 1 percent ether and water extracts. Effect of ether extract is comparatively more marked than water extract. However, the stimulatory effect of treatments are maintained throughout the duration of the observations.

Results were statistically analysed following analysis of variance method and observed increase are significant.

PHOTO - 8 : SHOWING EFFECT OF 24 HOURS PRE-SOAKING TREATMENT WITH EXTRACTS OF ***Spirodella polyrhiza*** PLANTS ON GROWTH AND YIELD OF WHEAT PLANTS



CONTROL

1 PERCENT
ETHER - WATER EXTRACT

INFLUENCE ON NUMBER OF LEAVES PER PLANT :

Observations entered in Table-9 and Figure-9 exhibit that number of leaves increases under treatments with both 1 percent ether and water extracts. Effect of ether extract is comparatively more pronounced than water extract. However, the beneficial effect of treatments are sustained throughout the duration of crop.

Results were statistically analysed following analysis of variance method and observed increase are significant.

INFLUENCE ON LENGTH OF LEAVES :

A perusal of Table-9 and Figure-9 exhibits that length of leaves slightly increases under treatments with both 1 percent ether and water extracts. Effect of ether extract is comparatively more effective than water extract. However, the stimulatory effect of treatments are maintained throughout the duration of the crop.

Results were statistically analysed following analysis of variance method and observed increase are insignificant.

INFLUENCE ON BREADTH OF LEAVES :

An examination of Table-9 and Figure-9 shows that breadth of leaves slightly increases under treatments with both

1 percent ether and water extracts. Effect of ether extract is comparatively more marked than water extract. However, the beneficial effect of treatment are sustained throughout the duration of the observations.

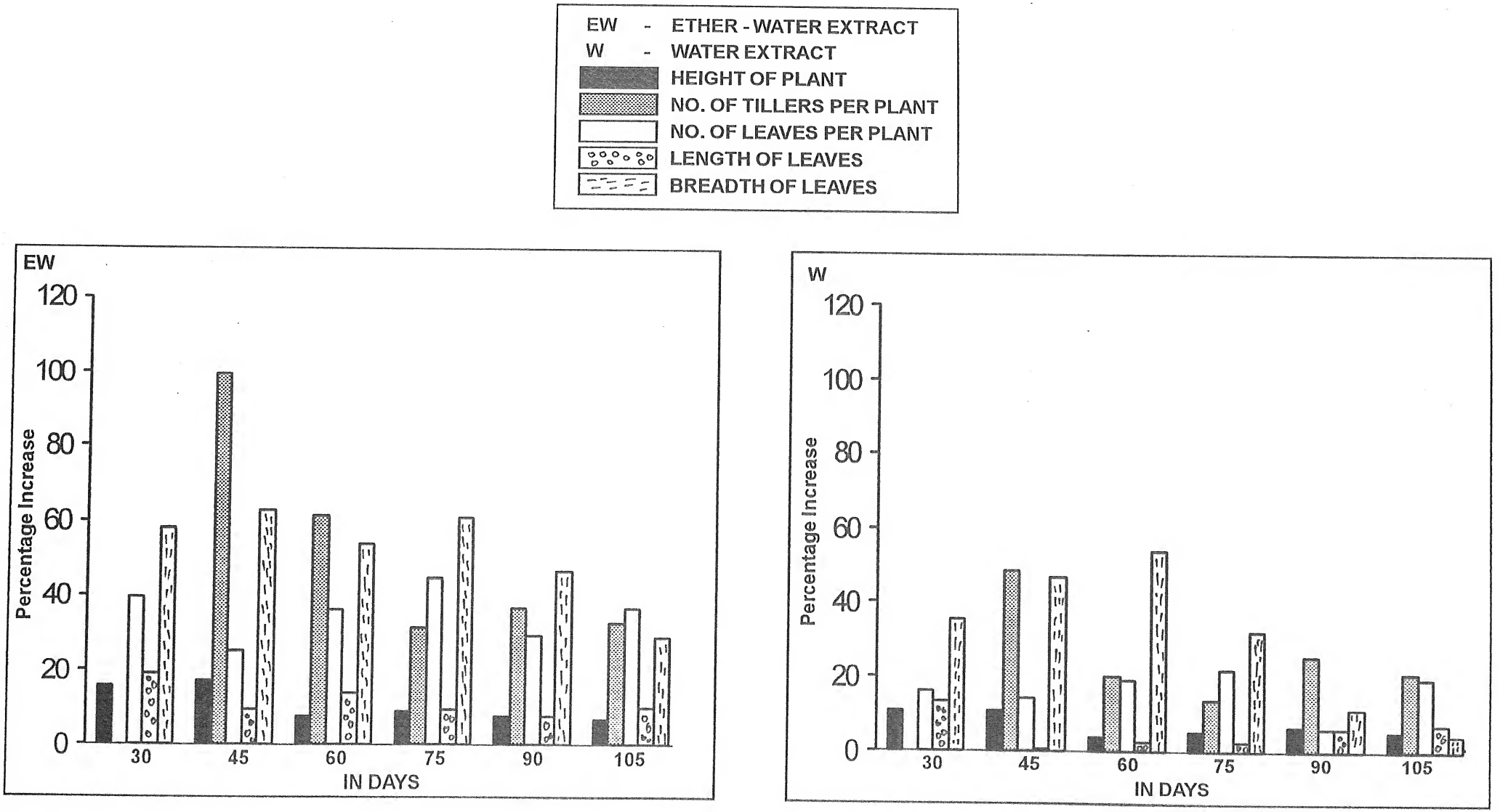
Results were statistically analysed following analysis of variance method and observed increase with 1 percent ether extract is significant.

TABLE - 9 : EFFECT OF 24 HOURS PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACTS ON VEGETATIVE GROWTH OF WHEAT PLANTS

DAYS	HEIGHT OF PLANTS IN CM			NO. OF TILLERS PER PLANT			NO. OF LEAVES PER PLANT			LENGTH OF LEAVES IN CM			BREADTH OF LEAVES IN CM		
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W
30	24.61	28.72	27.31	0.00	0.00	0.00	8.71	12.16	10.12	11.14	13.26	12.61	0.71	1.12	0.96
45	42.25	49.41	46.83	4.92	9.81	7.31	27.32	34.18	31.13	22.91	25.11	23.01	1.25	2.03	1.83
60	69.71	75.12	72.23	8.47	13.65	10.14	43.21	58.93	51.41	27.62	31.42	28.31	1.73	2.66	2.26
75	80.91	88.28	85.17	14.02	18.38	15.65	57.08	82.53	69.52	30.53	33.36	31.22	2.14	3.44	2.82
90.	84.03	90.35	89.40	15.22	20.79	19.08	17.64	91.16	74.81	31.44	33.87	33.39	2.61	2.82	2.91
105	85.47	91.13	89.79	16.00	21.19	19.31	72.23	98.72	86.11	32.01	35.15	34.32	3.02	3.88	3.15
	C.D. = 1.24 DIFFERENCE : 1% EW-C = 5.66 DIFFERENCE : 1% W-C = 4.32			C.D. = 2.06 DIFFERENCE : 1% EW-C = 5.19 DIFFERENCE : 1%W-C = 3.31			C.D. = 9.21 DIFFERENCE : 1% EW-C = 26.49 DIFFERENCE : 1%W-C = 1.88			C.D. = 1.11 DIFFERENCE : 1% EW-C = 3.14 DIFFERENCE : 1%W-C = 2.31			C.D. = 0.36 DIFFERENCE : 1% EW-C = 1.86 DIFFERENCE : 1%W-C = 0.13		

ABBREVIATIONS USED : C- Control, EW- Ether-Water extract, W- Water extract and C.D.- Critical Difference.

FIGURE - 9 : EFFECT OF 24 HOURS PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACT ON VEGETATIVE GROWTH OF WHEAT PLANT



EFFECT OF ETHER AND WATER EXTRACTS ON VEGETATIVE DRY MATTER, YIELD AND EAR EMERGENCE OF WHEAT :

INFLUENCE OF 6 HRS TREATMENT :

DRY WEIGHT OF STRAW :

Observations entered in Table-10 and Figure-10 show that there is an increase in dry weight of straw, under treatments with both 1 percent ether and 2 percent water extracts. However, the effect of 1 percent ether extract is more pronounced than water extract.

Statistical analysis of data shows that observed effects are significant at 5 percent error probability.

DRY WEIGHT OF EARS :

Results given in Table-10 and Figure-10 show that there is an increase in dry weight of ears under treatments with both 1 percent ether and 2 percent water extracts. However, the effect of 1 percent ether extract is more stimulatory than water extract.

Results were statistically analysed following analysis of variance method and observed increases were significant at 5 percent error probability.

DRY WEIGHT OF SINGLE EAR :

A perusal of Table-10 and Figure-10 exhibits that there is an increase in dry weight of single ear under treatments with both 1 percent ether and 2 percent water extracts. However, the effect of 1 percent ether extract is more pronounced than water extract.

Statistical analysis of data shows that observed effects are significant at 5 percent error probability.

DRY WEIGHT OF 1000 SEEDS :

An examination of Table-10 and Figure-10 indicates that there is an increase in dry weight of 1000 seeds under treatments with both 1 percent ether and 2 percent water extracts. However the effect of 1 percent ether extract is more stimulatory than water extract.

Results were statistically analysed following analysis of variance method and observed increase with both 1 percent ether and 2 percent water extracts were significant at 5 percent error probability.

PERCENTAGE EAR EMERGENCE :

Observations entered in Table-10 and Figure-10 suggest that there is an increase in percentage ear emergence under

TABLE - 10 : INFLUENCE OF PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON VEGETATIVE DRY MATTER, YIELD AND EAR EMERGENCE OF WHEAT

SOAKING PERIOD	DRY WT. OF STRAW PER PLANT IN GM			DRY WT. OF EARS PER PLANT IN GM			DRY WT. OF SINGLE EAR IN GM			DRY WT. OF 1000 SEEDS IN GM			PERCENTAGE EAR EMERGENCE PER DAY		
	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W
6 HRS	21.38	52,71	34.84	26.86	59.15	45.36	1.81	3.66	2.93	30.72	38.64	35.78	4.10	7.53	6.35
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W
12 HRS	26.89	79.47	42.92	33.14	81.37	73.22	2.32	3.98	3.43	33.61	41.32	39.25	6.08	8.05	7.11
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W
24 HRS	20.43	49.68	33.77	26.35	48.42	39.53	1.65	2.89	2.51	28.93	36.41	32.46	3.91	6.78	5.82
	C.D. = 16.00			C.D. = 18.18			C.D. = 0.36			C.D. = 1.33			C.D. = 0.91		
	DIFFERENCE : 6 HRS			DIFFERENCE : 6 HRS			DIFFERENCE : 6 HRS			DIFFERENCE : 6 HRS			DIFFERENCE : 6 HRS		
	1% EW-C = 31.33			1% EW-C = 32.29			1% EW-C = 1.85			1% EW-C = 7.92			1% EW-C = 3.43		
	2% W-C = 13.46			2% W-C = 18.50			2% W-C = 1.12			2% W-C = 5.06			2% W-C = 2.25		
	DIFFERENCE : 12 HRS			DIFFERENCE : 12 HRS			DIFFERENCE : 12 HRS			DIFFERENCE : 12 HRS			DIFFERENCE: 12 HRS		
	1% EW-C = 52.58			1% EW-C = 48.23			1% EW-C = 1.66			1% EW-C = 7.71			1% EW-C = 1.97		
	1% W-C = 16.03			1% W-C = 40.08			1% W-C = 1.11			1% W-C = 5.64			1% W-C = 1.03		
	DIFFERENCE : 24 HRS			DIFFERENCE : 24 HRS			DIFFERENCE : 24 HRS			DIFFERENCE : 24 HRS			DIFFERENCE: 24 HRS		
	1% EW-C = 29.05			1% EW-C = 22.07			1% EW-C = 1.24			1% EW-C = 7.48			1% EW-C = 2.87		
	1% W-C = 13.34			1% W-C = 13.18			1% W-C = 0.86			1% W-C = 3.53			1% W-C = 1.91		

ABBREVIATIONS USED : C- Control, EW- Ether-Water extract, W- Water extract and C.D. - Critical Difference

treatments with both 1 percent ether and 2 percent water extracts. However, the effect of 1 percent ether is more stimulatory than 2 percent water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

TIME REQUIRED FOR EAR EMERGENCE :

Results given in Table-11 and Figure-11 indicate that treatments with 1 percent ether and 2 percent water extracts induce earlier fruiting and ear emergence. However, the effect of 1 percent ether extract is more pronounced as compared with 2 percent water extract.

Statistical analysis of data shows that observed effects are significant at 5 percent error probability.

INFLUENCE OF 12 HRS TREATMENT :

DRY WEIGHT OF STRAW :

Perusal of Table-10 and Figure-10 shows that both 1 percent ether and water extracts impart stimulatory effect on dry weight of straw. However, the effect of 1 percent ether extract is more effective than water extract.

Results were statistically analysed following analysis

variance method and observed increase with both 1 percent ether and water extracts were significant at 5 percent error probability.

DRY WEIGHT OF EARS :

An examination of Table-10 and Figure-10 indicates that both 1 percent ether and water extracts exercise stimulatory effect on dry weight of ears. However, the effect of 1 percent ether extract is more pronounced than water extract.

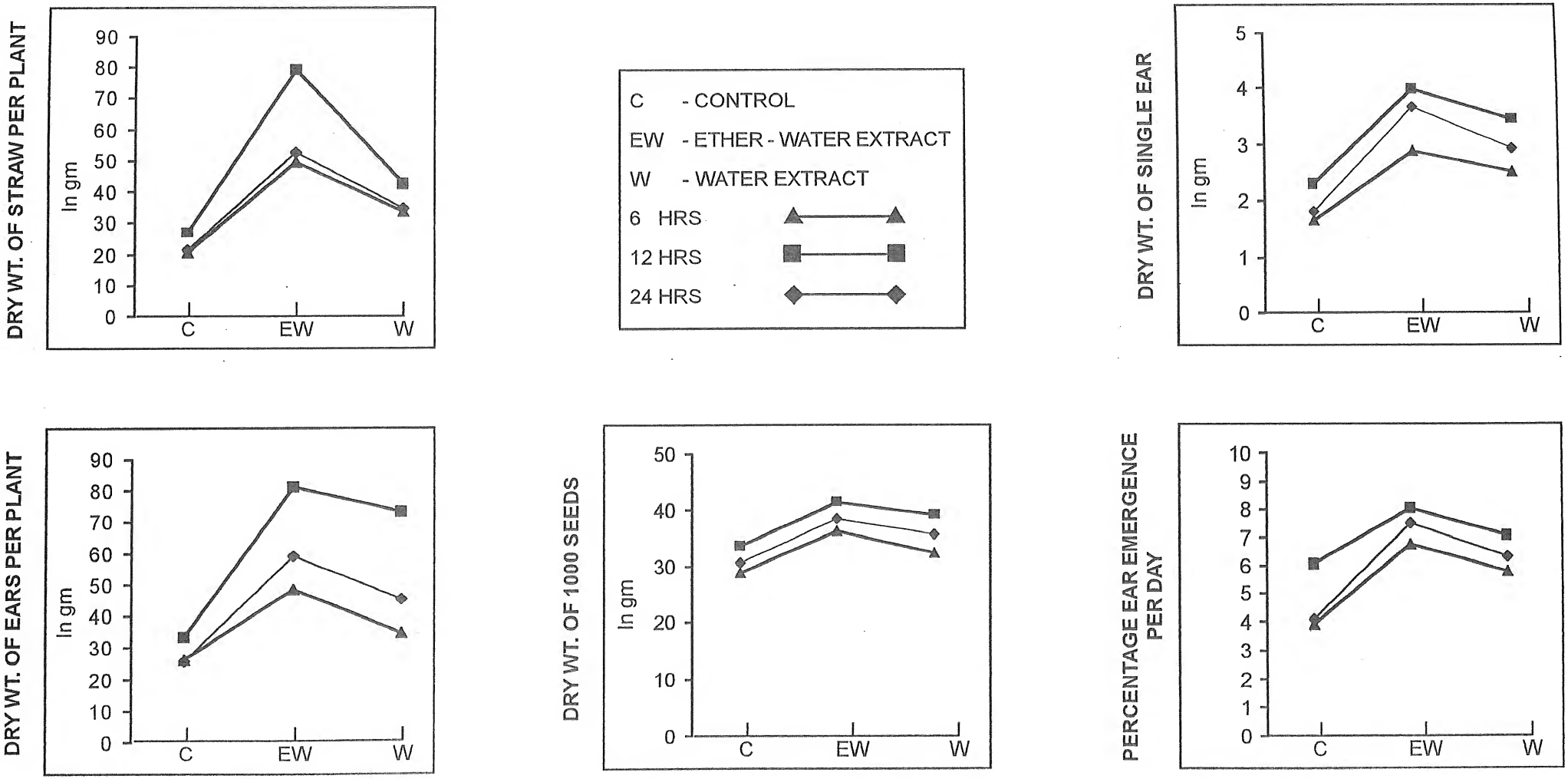
Statistical analysis of data shows that observed effects with both 1 percent water and ether extracts are significant at 5 percent error probability.

DRY WEIGHT OF SINGLE EAR :

Results given in Table-10 and Figure-10 suggest that both 1 percent ether and water extracts impart stimulatory effect on dry weight of single ear. However, the effect of 1 percent ether extract is more effective than water extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and water extracts were significant at 5 percent error probabililty.

FIGURE - 10 : INFLUENCE OF PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACTS ON VEGETATIVE DRY MATTER, GRAIN YIELD AND EAR EMERGENCE OF WHEAT



DRY WEIGHT OF 1000 SEEDS :

Observations entered in Table-10 and Figure-10 show that both 1 percent ether and water extracts exercise stimulatory effect on dry weight of 1000 seeds. However, the effect of 1 percent ether extract is more pronounced than water extract.

Statistical analysis of data shows that observed effects are significant at 5 percent error probability.

PERCENTAGE EAR EMERGENCE :

A perusal of Table-10 and Figure-10 suggests that both 1 percent ether and water extracts impart stimulatory effect on percentage ear emergence. However, the effect of 1 percent ether extract is more pronounced than water extract.

Results were statistically analysed following analysis of variance method and observed effects with both 1 percent ether and water extracts are significnat at 5 percent error probability.

TIME REQUIRED FOR EAR EMERGENCE :

Results given is Table-11 and Figure-11 indicate that treatment with 1 percent ether and 2 percent water extracts induce earlier fruiting and ear emergence. However. The effect of 1 percent ether extract is more pronounced as

compared with 2 percent water extract.

Results were statistically analysed and observed influence time of ear emergence is significant with both 1 percent ether and water extracts at 5 percent error probability.

INFLUENCE OF 24 HRS TREATMENT :

DRY WEIGHT OF STRAW :

A perusal of Table-10 and Figure-10 exhibits that both 1 percent ether and water extracts impart stimulatory effects on dry weight of straw. However, the effect of 1 percent ether extract is more pronounced than water extract.

Statistical analysis of data shows that observed effect of 1 percent ether extract is significant at 5 percent error probability.

DRY WEIGHT OF EARS :

An examination of Table-10 and Figure-10 shows that both 1 percent ether and water extracts impart stimulatory effect on dry weight of ears. However, the effect of 1 percent ether extract is more effective than water extract.

Results were statistically analysed following analysis of variance method and observed increase with 1 percent ether extract was significant at 5 percent error probability.

TABLE - 11 : EFFECT OF 6, 12 AND 24 HOURS PRE-SOAKING SEED TREATMENTS WITH ***Spirodella polyrhiza*** ON TIME REQUIRED FOR EAR EMERGENCE ON WHEAT PLANTS

SOAKING PERIOD	TIME REQUIRED FOR EAR EMERGENCE (IN DAYS)		
	C	1% EW	2% W
6 HRS	82	70	78
	C	1% EW	1% W
12 HRS	79	68	76
	C	1% EW	1% W
24 HRS	86	74	81
	C.D. = 1.19	DIFFERENCE : 6 HRS 1% EW - C= 12 DIFFERENCE : 12 HRS 1% EW -C = 11 DIFFERENCE : 24 HRS 1% EW - C = 12	DIFFERENCE : 6 HRS 2% W - C = 4 DIFFERENCE : 12 HRS 1% W -C = 3 DIFFERENCE : 24 HRS 1% W - C = 5

ABBREVIATIONS USED : C- Control, W- Water extract, EW- Ether-Water extract and C.D.- Critical Difference.

DRY WEIGHT OF SINGLE EAR :

Results given in Table-10 and Figure-10 indicate that both 1 percent ether and water extracts exercise stimulatory effect on dry weight of single ear. However, the effect of ether extract is more marked as compared to water extract.

Results were statistically analysed following analysis of variance method and observed increase with both 1 percent ether and water extracts are significant at 5 percent error probability.

DRY WEIGHT OF 1000 SEEDS :

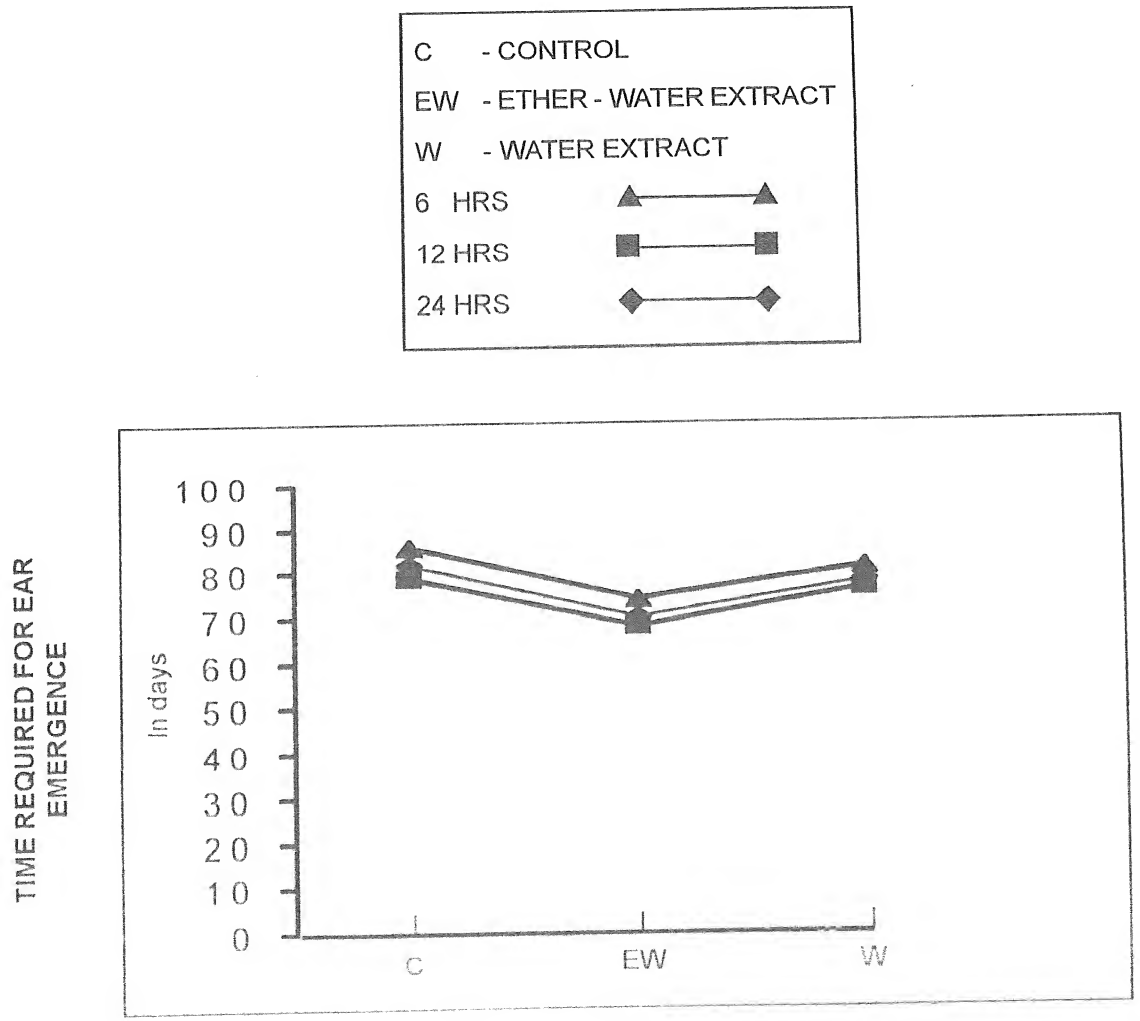
Observations entered in Table-10 and Figure-10 suggest that both 1 percent ether and water extracts exercise stimulatory effect on dry weight of 1000 seeds. However, the effect of ether extract is more pronounced than water extract.

Statistical analysis of data shows that observed increases with both 1 percent ether and water extracts are significant at 5 percent error probability.

PERCENTAGE EAR EMERGENCE :

A perusal of Table-10 and Figure-10 exhibits that both 1 percent ether and water extracts impart stimulatory effect on percentage of ear emergence. However, the effect of 1

FIGURE - 11 : EFFECT OF 6, 12 AND 24 HOURS PRE-SOAKING TREATMENT WITH *Spirodella polyrhiza* ON TIME REQUIRED FOR EAR EMERGENCE ON WHEAT PLANT



percent ether extract is more pronounced than water extract.

Results were statistically analysed following analysis of variance method and observed effects with both 1 percent ether and water extracts were significant at 5 percent error probability.

TIME REQUIRED FOR EAR EMERGENCE :

Results given in Table-11 and Figure-11 indicate that treatments with 1 percent ether and 2 percent water extracts induce earlier fruiting and ear emergence. However, the effect of 1 percent ether extract is more pronounced as compared with 2 percent water extract.

Statistical analysis of data shows that observed effects are significant at 5 percent error probability.

CHAPTER 3

STUDIES ON EFFECTS OF *Spirodella polyrhiza* EXTRACTS ON QUALITY OF WHEAT STRAW AND GRAINS.

STUDIES ON EFFECTS OF *Spirodella polyrhiza* EXTRACTS ON QUALITY OF WHEAT STRAW AND GRAINS

INFLUENCE OF 6 HRS PRE-SOAKING SEED TREATMENT ON NITROGEN CONTENT IN WHEAT:

EFFECT ON ROOT CONSTITUENT :

Results given in Table-12 and Figure-12 show that treatments with 1 percent ether and 2 percent water extracts exercise increase in Nitrogen percentage of root over control. However, 1 percent ether extract is comparatively more effective than water extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and 2 percent water extracts are insignificant at 5 percent error probability.

EFFECT ON STEM CONSTITUENT :

Observations entered in Table-12 and Figure-12 show that treatments with 1 percent ether and 2 percent water extracts exercise increase in nitrogen percentage of stem over control. However, 1 percent ether extract is comparatively more stimulatory than water extract.

Statistical analysis of data shows that observed effect with 1 percent ether extract is significant at 5 percent error probability.

EFFECT ON LEAF CONSTITUENT :

A perusal of Table-12 and Figure-12 shows that treatments with 1 percent ether and 2 percent water extracts exercise increase in nitrogen percentage of leaf over control. However, 1 percent ether extract is more effective than water extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

EFFECT ON GRAIN CONSTITUENT :

An examination of Table-12 and Figure-12 shows that nitrogen percentage in grain is higher under treatments with both 1

TABLE - 12 : EFFECT OF *Spirodella polyrhiza* EXTRACTS ON NITROGEN PERCENTAGE OF WHEAT

SOAKING PERIOD	ROOT			STEM			LEAF			GRAIN		
	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W
6 HRS	0.34	0.37	0.35	0.36	0.45	0.39	0.38	0.59	0.55	2.15	2.31	2.25
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W
12 HRS	0.36	0.52	0.48	0.38	0.50	0.47	0.41	0.66	0.62	2.19	2.42	2.37
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W
24 HRS	0.33	0.36	0.34	0.34	0.41	0.38	0.37	0.57	0.49	2.13	2.29	2.21
	C.D. = 0.09			C.D. = 0.04			C.D. = 0.05			C.D. = 0.06		
	DIFFERENCE : 6 HRS			DIFFERENCE : 6 HRS			DIFFERENCE : 6 HRS			DIFFERENCE : 6 HRS		
	1% EW-C = 0.03			1% EW-C = 0.09			1% EW-C = 0.21			1% EW-C = 0.16		
	2% W-C = 0.01			2% W-C = 0.03			2% W-C = 0.17			2% W-C = 0.10		
	DIFFERENCE : 12 HRS			DIFFERENCE : 12 HRS			DIFFERENCE : 12 HRS			DIFFERENCE : 12 HRS		
	1%EW-C = 0.16			1%EW-C = 0.12			1%EW-C = 0.25			1%EW-C = 0.26		
	1% W-C = 0.12			1% W-C = 0.09			1% W-C = 0.21			1% W-C = 0.18		
	DIFFERENCE : 24 HRS			DIFFERENCE : 24 HRS			DIFFERENCE : 24 HRS			DIFFERENCE : 24 HRS		
	1% EW-C = 0.03			1% EW-C = 0.07			1% EW-C = 0.20			1% EW-C = 0.16		
	1% W-C = 0.01			1% W-C = 0.04			1% W-C = 0.12			1% W-C = 0.08		

ABBREVIATIONS USED : C- Control, EW- Ether-Water extract, W- Water extract and C.D. - Critical Difference.

percent ether and 2 percent water extracts. However, 1 percent ether extract is more pronounced than water extract.

Statistical analysis of data shows that observed effects with 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

INFLUENCE OF 12 HRS PRE-SOAKING SEED TREATMENT ON NITROGEN CONTENT IN WHEAT:

EFFECT ON ROOT CONSTITUENT :

Observations given in Table-12 and Figure-12 exhibit that treatments with 1 percent ether and water extracts exercise increase in nitrogen percentage of root over control. However, 1 percent ether extract is comparatively more beneficial than water extract.

Results were statistically analysed following analysis of variance method and observed increases with 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON STEM CONSTITUENT :

Results given in Table-12 and Figure-12 show that treatments with 1 percent ether and water extracts exercise increase in nitrogen percentage of stem over control. However, 1 percent ether extract is comparatively more effective than

water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON LEAF CONSTITUENT :

A perusal of Table-12 and Figure-12 exhibits that treatments with 1 percent ether and water extracts exercise increase in nitrogen percentage of leaf over control. However, 1 percent ether extract is more stimulatory than water extract.

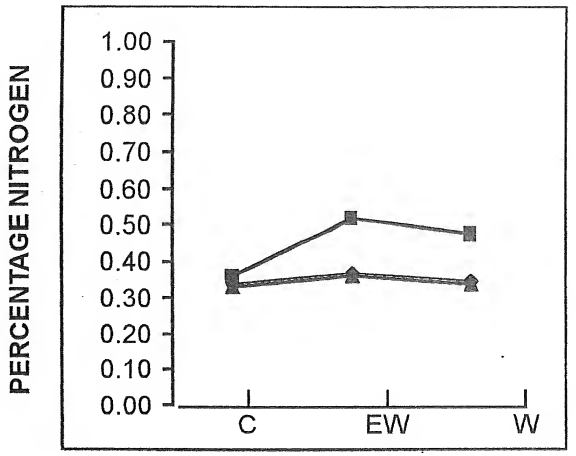
Results were statistically analysed following analysis of variance method and observed increase with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON GRAIN CONSTITUENT :

An examination of Table-12 and Figure-12 shows that treatments with both 1 percent ether and water extracts exercise increase in nitrogen percentage of grain over control. However, 1 percent ether extract is more pronounced than water extract.

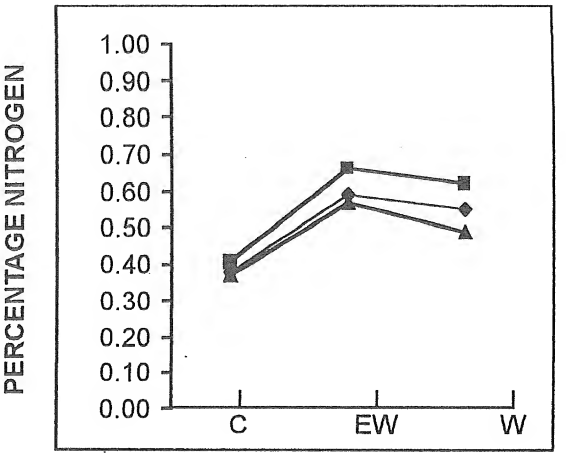
Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are significant

FIGURE - 12 : EFFECT OF *Spirodella polyrhiza* EXTRACTS ON NITROGEN CONTENT OF WHEAT

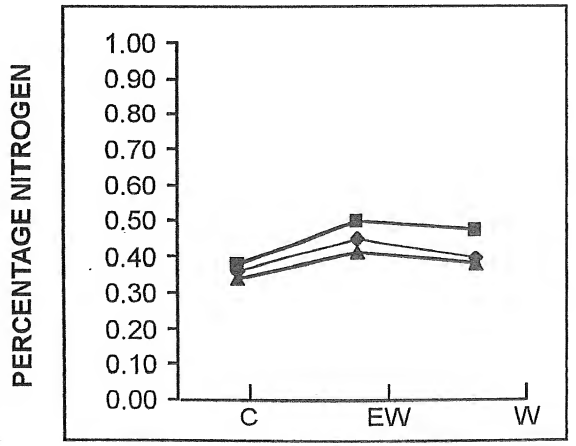


ROOT

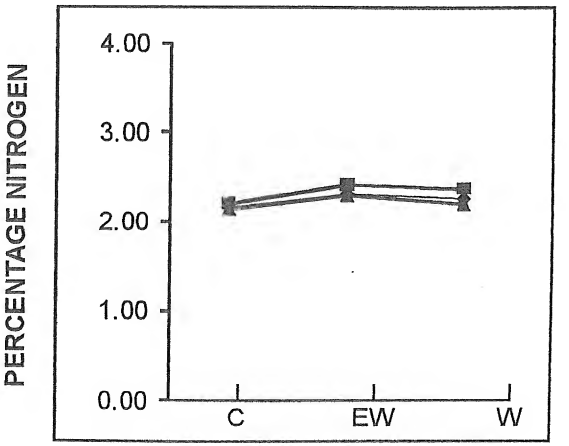
C - CONTROL
EW - ETHER - WATER EXTRACT
W - WATER EXTRACT
6 HRS
12 HRS
24 HRS



LEAF



STEM



GRAIN

at 5 percent error probability.

INFLUENCE OF 24 HRS PRE-SOAKING SEED TREATMENT ON NITROGEN CONTENT IN WHEAT:

EFFECT ON ROOT CONSTITUENT :

Observations given in Table-12 and Figure-12 exhibit that treatments with both 1 percent ether and water extracts exercise increase in nitrogen percentage of root over control. However, 1 percent ether extract is comparatively more stimulatory than water extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and water extracts are insignificant at 5 percent error probability.

EFFECT ON STEM CONSTITUENT :

Results given in Table-12 and Figure-12 show that treatments with 1 percent ether and water extracts exercise increase in nitrogen percentage of stem over control. However, 1 percent ether extract is comparatively more effective than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are significant

at 5 percent error probability.

EFFECT ON LEAF CONSTITUENT :

A perusal of Table-12 and Figure-12 exhibits that treatments with both 1 percent ether and water extracts exercise increase in nitrogen percentage of leaf over control. However, 1 percent ether extract is more stimulatory than water extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON GRAIN CONSTITUENT :

An examination of Table-12 and Figure-12 shows that treatments with both 1 percent ether and water extracts exercise increase in nitrogen percentage of grain over control. However, 1 percent ether extract is more pronounced than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

INFLUENCE OF 6 HRS PRE-SOAKING SEED TREATMENT ON PROTEIN CONTENT IN WHEAT:

EFFECT ON ROOT CONSTITUENT :

Results given in Table-13 and Figure-13 show that treatments with 1 percent ether and 2 percent water extracts exercise increase in protein percentage of root over control. However, 1 percent ether extract is comparatively more beneficial than water extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and 2 percent water extracts are insignificant at 5 percent error probability.

EFFECT ON STEM CONSTITUENT :

Observations entered in Table-13 and Figure-13 exhibit that treatments with 1 percent ether and 2 percent water extracts exercise increase in protein percentage of root over control. However, 1 percent ether extract is more stimulatory than water extract.

Statistical analysis of data shows that observed effect with 1 percent ether extract is significant at 5 percent error probability.

EFFECT ON LEAF CONSTITUENT :

A perusal of Table-13 and Figure-13 exhibits that treatments with both 1 percent ether and 1 percent water extracts exercise increase in protein percentage of leaf over control. However, 1 percent ether extract is more stimulatory than water extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

EFFECT ON GRAIN CONSTITUENT :

An examination of Table-13 and Figure-13 shows that protein percentage is higher under treatments with both 1 percent ether and 2 percent water extracts. However, 1 percent ether extract is more pronounced than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

TABLE - 13 : EFFECT OF *Spirodella polyrhiza* EXTRACTS ON PROTEIN PERCENTAGE OF WHEAT

SOAKING PERIOD	ROOT			STEM			LEAF			GRAIN		
	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W
6 HRS	2.12	2.31	2.19	2.25	2.81	2.44	2.37	3.69	3.44	13.44	14.44	14.06
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W
12 HRS	2.25	3.25	3.00	2.37	3.12	2.94	2.56	4.12	3.87	13.69	15.12	14.81
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W
24 HRS	2.06	2.25	2.12	2.12	2.56	2.37	2.31	3.56	3.06	13.31	14.31	13.81
	C.D. = 0.62			C.D. = 0.26			C.D. = 0.33			C.D. = 0.39		
	DIFFERENCE : 6HRS			DIFFERENCE : 6HRS			DIFFERENCE : 6HRS			DIFFERENCE : 6HRS		
	1% EW-C = 0.19			1% EW-C = 0.56			1% EW-C = 1.32			1% EW-C = 1.00		
	2% W-C = 0.07			2% W-C = 0.19			2% W-C = 1.07			2% W-C = 0.62		
	DIFFERENCE : 12 HRS			DIFFERENCE : 12 HRS			DIFFERENCE : 12 HRS			DIFFERENCE : 12 HRS		
	1%EW-C = 1.00			1%EW-C = 0.75			1%EW-C = 1.56			1%EW-C = 1.43		
	1% W-C = 0.75			1% W-C = 0.57			1% W-C = 1.31			1% W-C = 1.12		
	DIFFERENCE : 24 HRS			DIFFERENCE : 24 HRS			DIFFERENCE : 24 HRS			DIFFERENCE : 24 HRS		
	1% EW-C = 0.19			1% EW-C = 0.44			1% EW-C = 1.25			1% EW-C = 1.00		
	1% W-C = 0.06			1% W-C = 0.25			1% W-C = 0.75			1% W-C = 0.50		

ABBREVIATIONS USED : C- Control, EW- Ether-Water extract, W- Water extract and C.D. - Critical Difference.

INFLUENCE OF 12 HRS PRE-SOAKING SEED TREATMENT ON PROTEIN CONTENT IN WHEAT:

EFFECT ON ROOT CONSTITUENT :

Observations given in Table-13 and Figure-13 exhibit that treatments with both 1 percent ether and water extracts exercise increase in protein percentage of root over control. However, 1 percent ether extract is comparatively more beneficial than water extract.

Results were statistically analysed following analysis of variance method and observed increase with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON STEM CONSTITUENT :

Results given in Table-13 and Figure-13 show that treatments with both 1 percent ether and water extracts exercise increase in protein percentage of stem. However, 1 percent ether extract is comparatively more effective than water extract.

Statistical analysis of data shows that observed effects with 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON LEAF CONSTITUENT :

A perusal of Table-13 and Figure-13 exhibits that treatments with both 1 percent ether and water extracts exercise increase in protein percentage over control. However, 1 percent ether extract is more stimulatory than water extract.

Results were statistically analysed following analysis of variance method and observed increase with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON GRAIN CONSTITUENT :

An examination of Table-13 and Figure-13 shows that treatments with 1 percent ether and water extracts exercise increase in protein percentage. However, 1 percent ether extract is more pronounced than water extract.

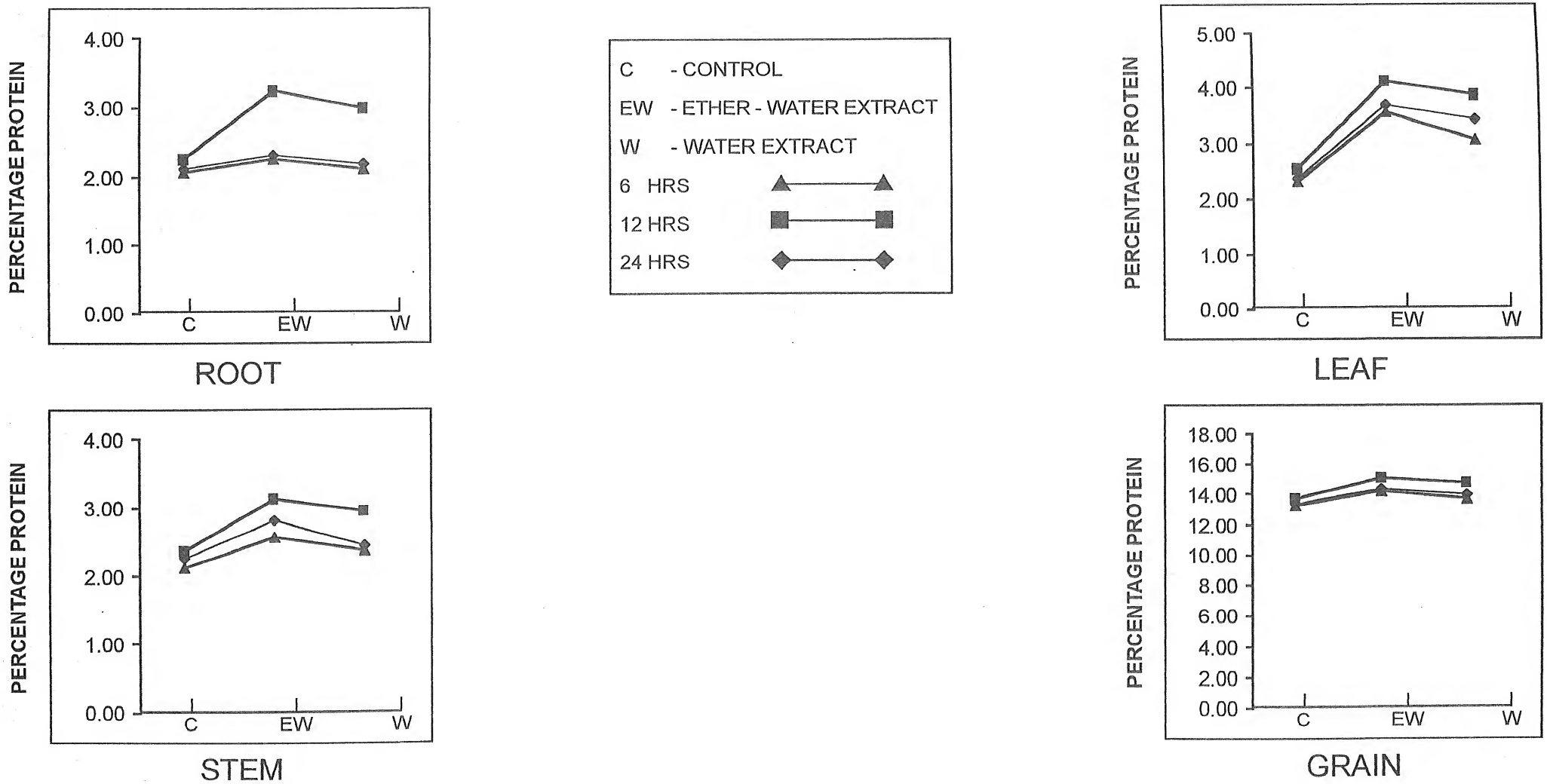
Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

INFLUENCE OF 24 HRS PRE-SOAKING SEED TREATMENT ON PROTEIN CONTENT IN WHEAT:

EFFECT ON ROOT CONSTITUENT :

Observations given in Table-13 and Figure-13 show that

FIGURE - 13 : EFFECT OF *Spirodella polyrhiza* EXTRACTS ON PROTEIN CONTENT OF WHEAT



treatments with 1 percent ether and water extract exercise increase in protein percentage of root over control. However, 1 percent ether extract is comparatively more beneficial than water extract.

Results were statistically analysed following analysis of variance method and observed effects with both, 1 percent ether and water extract are insignificant at 5 percent error probability.

EFFECT ON STEM CONSTITUENT :

Results given in Table-13 and Figure-13 show that treatments with both 1 percent ether and water extracts exercise increase in protein percentage of stem over control. However, 1 percent ether extract is comparatively more effective than water extract.

Statistical analysis of data shows that observed effect with 1 percent ether extract is significant at 5 percent error probability.

EFFECT ON LEAF CONSTITUENT :

A perusal of Table-13 and Figure-13 exhibits that treatments with both 1 percent ether and water extracts exercise increase in protein percentage of leaf over control. However, 1 percent ether extract is comparatively more stimulatory than water

extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON GRAIN CONSTITUENT :

An examination on Table-13 and Figure-13 shows that treatments with 1 percent ether and water extracts exercise increase in protein percentage of grain over control. However, 1 percent ether extract is more pronounced than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

INFLUENCE OF 6 HRS PRE-SOAKING SEED TREATMENT ON PHOSPHORUS CONTENT IN WHEAT :

EFFECT ON ROOT CONSTITUENT :

Results given in Table-14 and Figure-14 show that treatments with 1 percent ether and 2 percent water extracts exercise increase in phosphorus percentage of stem over control. However, 1 percent ether extract is comparatively

more stimulatory than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

EFFECT ON STEM CONSTITUENT :

Observations entered in Table-14 and Figure-14 exhibit that treatments with 1 percent ether and 2 percent water extracts exercise increase in phosphorus of root over control. However, percentage ether extract is more stimulatory than water extract.

Statistical analysis of data shows that observed effects with 1 percent ether and 2 percent water extracts are insignificant at 5 percent error probability.

EFFECT ON LEAF CONSTITUENT :

A perusal of Table-14 and Figure-14 shows that treatments with 1 percent ether and 2 percent water extracts exercise increase in phosphorus percentage of leaf over control. However, 1 percent ether extract is more effective than water extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent

TABLE - 14 : EFFECT OF *Spirodella polyrhiza* EXTRACTS ON PHOSPHORUS PERCENTAGE OF WHEAT

SOAKING PERIOD	ROOT			STEM			LEAF			GRAIN		
	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W
6 HRS	0.252	0.266	0.261	0.258	0.262	0.260	0.261	0.269	0.263	0.750	0.798	0.785
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W
12 HRS	0.259	0.273	0.270	0.265	0.279	0.274	0.266	0.278	0.274	0.775	0.861	0.845
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W
24 HRS	0.251	0.264	0.258	0.255	0.259	0.257	0.259	0.265	0.262	0.732	0.788	0.769
	C.D. = 0.00			C.D. = 0.01			C.D. = 0.01			C.D. = 0.03		
	DIFFERENCE : 6 HRS			DIFFERENCE : 6 HRS			DIFFERENCE : 6 HRS			DIFFERENCE : 6 HRS		
	1% EW-C = 0.014			1% EW-C = 0.004			1% EW-C = 0.008			1% EW-C = 0.048		
	2% W-C = 0.009			2% W-C = 0.002			2% W-C = 0.002			2% W-C = 0.035		
	DIFFERENCE : 12 HRS			DIFFERENCE : 12 HRS			DIFFERENCE : 12 HRS			DIFFERENCE : 12 HRS		
	1%EW-C = 0.014			1%EW-C = 0.014			1%EW-C = 0.012			1%EW-C = 0.086		
	1% W-C = 0.011			1% W-C = 0.009			1% W-C = 0.008			1% W-C = 0.070		
	DIFFERENCE : 24 HRS			DIFFERENCE : 24 HRS			DIFFERENCE : 24 HRS			DIFFERENCE : 24 HRS		
	1% EW-C = 0.013			1% EW-C = 0.004			1% EW-C = 0.006			1% EW-C = 0.056		
	1% W-C = 0.007			1% W-C = 0.002			1% W-C = 0.003			1% W-C = 0.037		

ABBREVIATIONS USED : C- Control, EW- Ether-Water extract, W- Water extract and C.D. - Critical Difference.

ether and 2 percent water extracts are insignificant at 5 percent error probability.

EFFECT ON GRAIN CONSTITUENT :

An examination of Table-14 and Figure-14 shows that phosphorus percentage is higher under treatments with both 1 percent ether and 2 percent water extracts. However, effect of 1 percent ehter extract is more pronounced than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

INFLUENCE OF 12 HRS PRE-SOAKING SEED TREATMENT ON PHOSPHORUS CONTENT IN WHEAT :

EFFECT ON ROOT CONSTITUENT :

Observations given in Table-14 and Figure-14 exhibit that treatments with 1 percent ether and water extracts exercise increase in phosphorus percentage of root over control. However, 1 percent ether extract is comparatively more beneficial than water extract.

Results were statistically analysed following analysis of

variance method and observed increases with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON STEM CONSTITUENT :

Results given in Table-14 and Figure-14 show that treatments with both 1 percent ether and water extracts exercise increase in phosphorus percentage of stem over control. However, 1 percent ether extract is comparatively more effective than water extract.

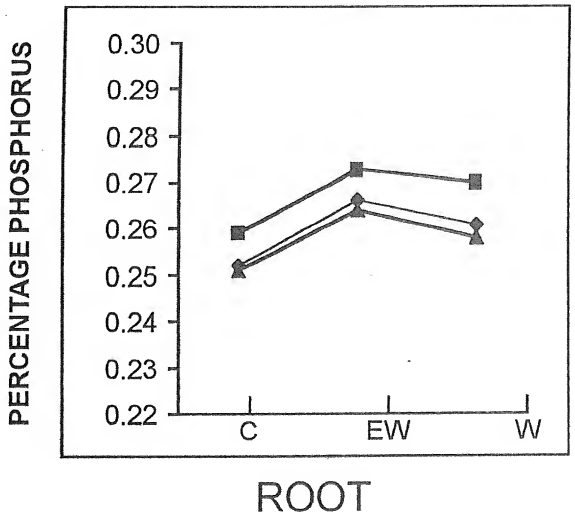
Statistical analysis of data shows that observed effect with 1 percent ether extract is significant at 5 percent error probability.

EFFECT ON LEAF CONSTITUENT :

A perusal of Table-14 and Figure-14 exhibits that treatments with both 1 percent ether and water extracts exercise increase in phosphorus percentage of leaf over control. However, 1 percent ether extract is more stimulatory than water extract.

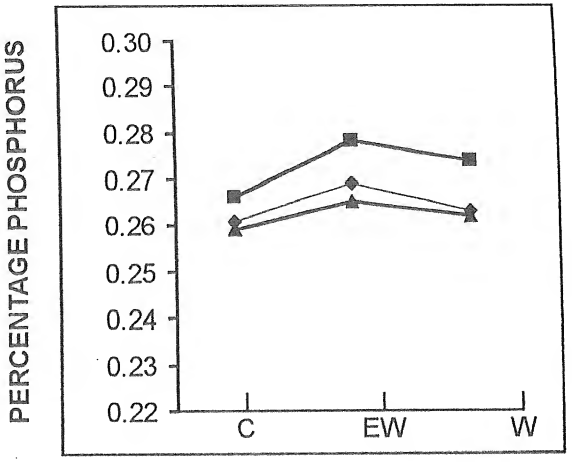
Results were statistically analysed following analysis of variance method and observed effect with 1 percent ether extract is significant at 5 percent error probability.

FIGURE - 14 : EFFECT OF *Spirodella polyrhiza* EXTRACTS ON PHOSPHORUS CONTENT OF WHEAT

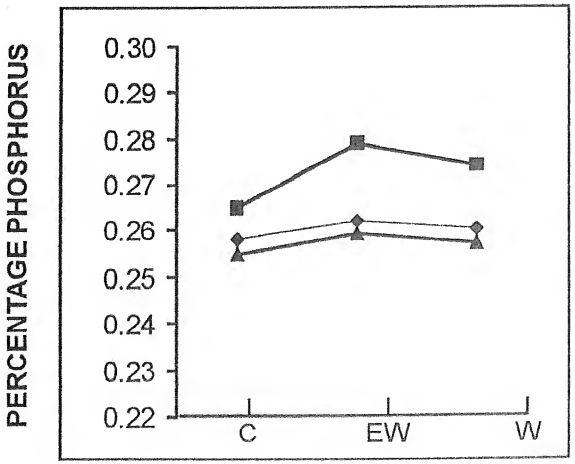


ROOT

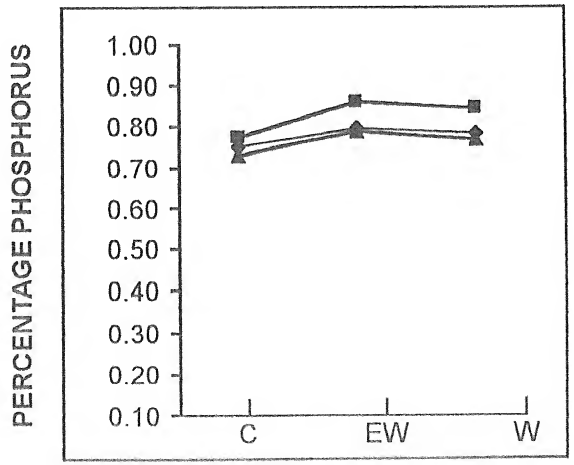
C - CONTROL
EW - ETHER - WATER EXTRACT
W - WATER EXTRACT
6 HRS
12 HRS
24 HRS



LEAF



STEM



GRAIN

EFFECT ON GRAIN CONSTITUENT :

An examination of Table-14 and Figure-14 shows that treatments with both 1 percent ether and water extracts exercise increase in phosphorus percentage of grain over control. However, 1 percent ether extract is more pronounced than water extract.

Statistical analysis of data shows that observed effects with 1 percent ether and water extracts are significant at 5 percent error probability.

INFLUENCE OF 24 HRS PRE-SOAKING SEED TREATMENT ON PHOSPHORUS CONTENT IN WHEAT :

EFFECT ON ROOT CONSTITUENT :

Observations given in Table-14 and Figure-14 show that treatments with 1 percent ether and water extracts exercise increase in phosphorus percentage of root over control. However, 1 percent ether extract is comparatively more beneficial than water extract.

Results were statistically analysed following analysis of variance method and observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON STEM CONSTITUENT :

Results given in Table-14 and Figure-14 show that treatments with both 1 percent ether and water extracts exercise increase in phosphorus percentage of stem over control. However, 1 percent ether extract is comparatively more effective than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are insignificant at 5 percent error probability.

EFFECT ON LEAF CONSTITUENT :

A perusal of Table-14 and Figure-14 exhibit that treatments with 1 percent ether and water extracts exercise increase in phosphorus percentage of leaf over control. However, 1 percent ether extract is comparatively more stimulatory than water extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and water extracts are insignificant at 5 percent error probability.

EFFECT ON GRAIN CONSTITUENT :

An examination of Table-14 and Figure-14 shows that

treatments with both 1 percent ether and water extracts exercise increase in phosphorus percentage of grain over control. However, 1 percent ether extract is more pronounced than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

INFLUENCE OF 6 HRS PRE-SOAKING SEED TREATMENT ON POTASH CONTENT IN WHEAT:

EFFECT ON ROOT CONSTITUENT :

Results given in Table-15 and Figure-15 show that treatments with 1 percent ether and 2 percent water extracts exercise increase in potash percentage of root over control. However, 1 percent ether extract in comparatively more beneficial towards increasing content than water extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

EFFECT ON STEM CONSTITUENT :

Observations entered in Table-15 and Figure-15 exhibit

that treatments with 1 percent ether and 2 percent water extracts exercise increase in potash percentage of stem. However, 1 percent ether extract is comparatively more stimulatory than water extract.

Statistical analysis of data shows that observed effect with 1 percent ether extract is significant at 5 percent error probability.

EFFECT ON LEAF CONSTITUENT :

A perusal of Table-15 and Figure-15 shows that treatments with 1 percent ether and 2 percent water extracts exercise increase in potash percentage of leaf over control. One percent ether extract is comparatively more effective than water extract.

Results were statistically analysed following analysis of variance method and observed effects with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

EFFECT ON GRAIN CONSTITUENT :

An examination of Table-15 and Figure-15 shows that potash percentage is higher under treatments with both 1 percent ether and 2 percent water extracts. Effect of 1 percent ether extract is more pronounced than water extract.

TABLE - 15 : EFFECT OF *Spirodella polyrhiza* EXTRACTS ON POTASH PERCENTAGE OF WHEAT

SOAKING PERIOD	ROOT			STEM			LEAF			GRAIN		
	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W
6 HRS	1.56	1.68	1.61	1.61	1.70	1.62	1.58	1.68	1.63	0.59	0.68	0.63
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W
12 HRS	1.60	1.71	1.69	1.70	1.79	1.75	1.66	1.81	1.76	0.69	0.77	0.74
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W
24 HRS	1.53	1.65	1.58	1.59	1.64	1.61	1.57	1.65	1.60	0.58	0.65	0.61
	C.D. = 0.03			C.D. = 0.04			C.D. = 0.05			C.D. = 0.02		
	DIFFERENCE : 6 HRS			DIFFERENCE : 6 HRS			DIFFERENCE : 6 HRS			DIFFERENCE : 6 HRS		
	1% EW-C = 0.12			1% EW-C = 0.09			1% EW-C = 0.10			1% EW-C = 0.09		
	2% W-C = 0.05			2% W-C = 0.01			2% W-C = 0.05			2% W-C = 0.04		
	DIFFERENCE : 12 HRS			DIFFERENCE : 12 HRS			DIFFERENCE : 12 HRS			DIFFERENCE : 12 HRS		
	1%EW-C = 0.11			1%EW-C = 0.09			1%EW-C = 0.15			1%EW-C = 0.09		
	1% W-C = 0.09			1% W-C = 0.05			1% W-C = 0.10			1% W-C = 0.05		
	DIFFERENCE : 24 HRS			DIFFERENCE : 24 HRS			DIFFERENCE : 24 HRS			DIFFERENCE : 24 HRS		
	1% EW-C = 0.12			1% EW-C = 0.05			1% EW-C = 0.08			1% EW-C = 0.07		
	1% W-C = 0.05			1% W-C = 0.02			1% W-C = 0.03			1% W-C = 0.03		

ABBREVIATIONS USED : C- Control, EW- Ether-Water extract, W- Water extract and C.D. - Critical Difference.

Statistical analysis of data shows that observed effects with 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

INFLUENCE OF 12 HRS PRE-SOAKING SEED TREATMENT ON POTASH CONTENT IN WHEAT:

EFFECT ON ROOT CONSTITUENT :

Observations given in Table-15 and Figure-15 exhibit that treatments with both 1 percent ether and water extracts exercise increase in potash percentage of root over control. However, 1 percent ether extract is comparatively more beneficial than water extract.

Results were statistically analysed following analysis of variance method and observed effects with 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON STEM CONSTITUENT :

Results given in Table-15 and Figure-15 show that treatments with 1 percent ether and water extracts exercise increase potash percentage of stem. Influence of 1 percent ether extract is comparatively more effective than water extract.

Statistical analysis of data shows that observed effects

with 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON LEAF CONSTITUENT :

A perusal of Table-15 and Figure-15 exhibits that treatments with 1 percent ether and water extracts exercise increase in potash percentage of leaf over control. However, 1 percent ether extract is comparatively more stimulatory than water extract.

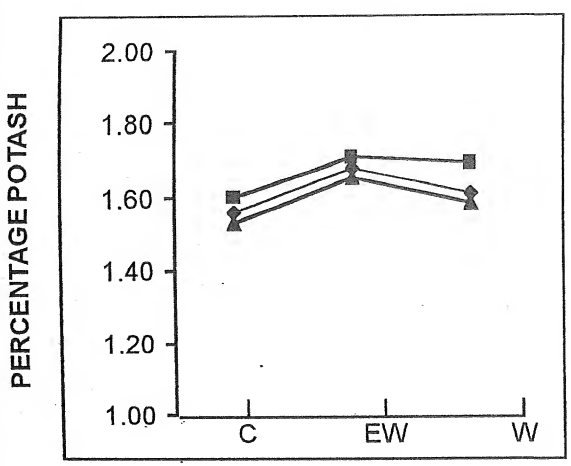
Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and water extracts are significant at 5 percent error porbability.

EFFECT ON GRAIN CONSTITUENT :

An examination of Table-15 and Figure-15 shows that treatments with both 1 percent ether and water extracts exercise increase in potash percentage of grain. Effectiveness of 1 percent ether extract is comparatively more pronounced than water extract.

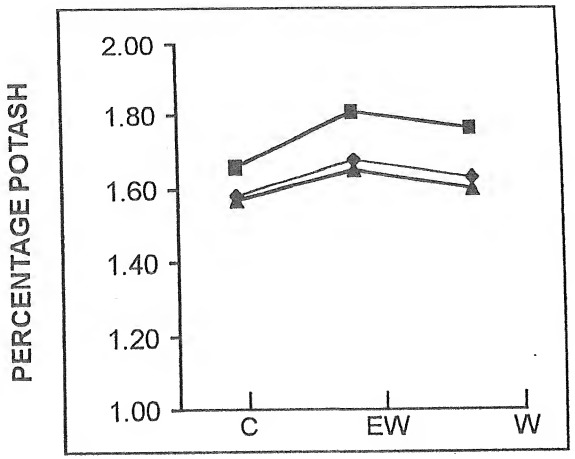
Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

FIGURE - 15 : EFFECT OF *Spirodella polyrhiza* EXTRACTS ON POTASH CONTENT OF WHEAT

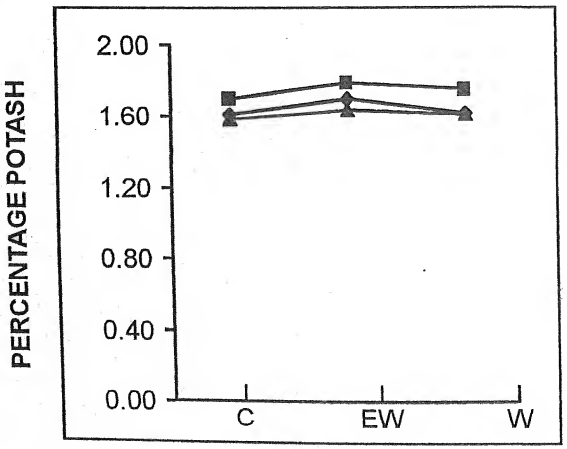


ROOT

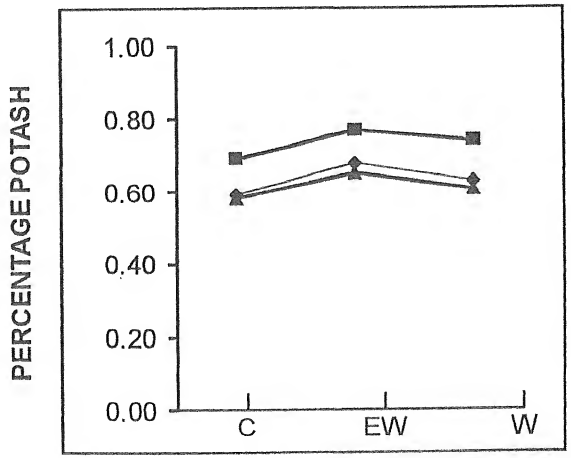
C - CONTROL
EW - ETHER - WATER EXTRACT
W - WATER EXTRACT
6 HRS
12 HRS
24 HRS



LEAF



STEM



GRAIN

INFLUENCE OF 24 HRS PRE-SOAKING SEED TREATMENT ON POTASH CONTENT IN WHEAT:

EFFECT ON ROOT CONSTITUENT :

Observations given in Table-15 and Figure-15 show that treatments with both 1 percent ether and water extracts exercise increase in potash percentage of root over control. However, 1 percent ether extract is comparatively beneficial to larger extent than water extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON STEM CONSTITUENT :

Results given in Table-15 and Figure-15 show that treatments with 1 percent ether and water extracts exercise increase in potash percentage of stem over control. However, 1 percent ether extract is comparatively more effective than water extract.

Statistical analysis of data shows that observed increase with 1 percent ether is significant at 5 percent error probability.

EFFECT ON LEAF CONSTITUENT :

A perusal of Table-15 and Figure-15 exhibits that treatments with both 1 percent ether and water extracts exercise increase in potash percentage of leaf over control. However, 1 percent ether extract is comparatively more stimulatory than water extract.

Results were statistically analysed following analysis of variance method and observed increase with 1 percent ether extract is significant at 5 percent error probability.

EFFECT ON GRAIN CONSTITUENT :

An examination of Table-15 and Figure-15 shows that treatments with both 1 percent ether and water extracts exercise increase in potash percentage of grain over control. However, 1 percent ether extract is comparatively more pronounced than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

CHAPTER 4

STUDIES ON MORPHO-ANATOMICAL RESPONSE OF WHEAT PLANTS TO *Spirodella polyrhiza* EXTRACTS AND ITS SIGNIFICANCE.

STUDIES ON MORPHO-ANATOMICAL RESPONSE OF WHEAT PLANTS TO *Spirodella polyrhiza* EXTRACTS AND ITS SIGNIFICANCE

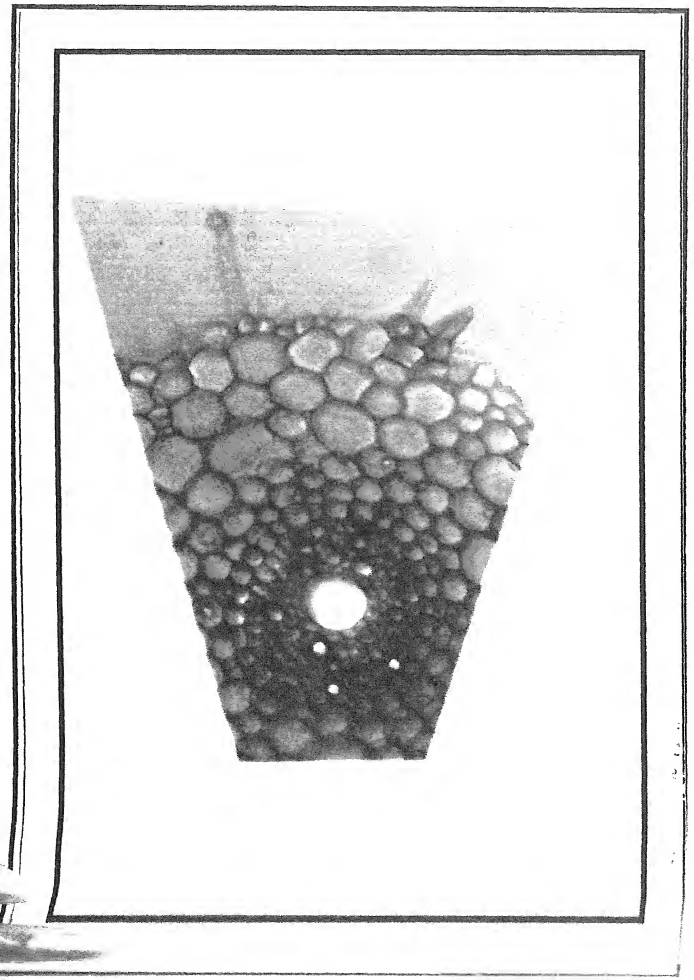
INFLUENCE OF 6 HRS PRE-SOAKING SEED TREATMENT ON ROOT :

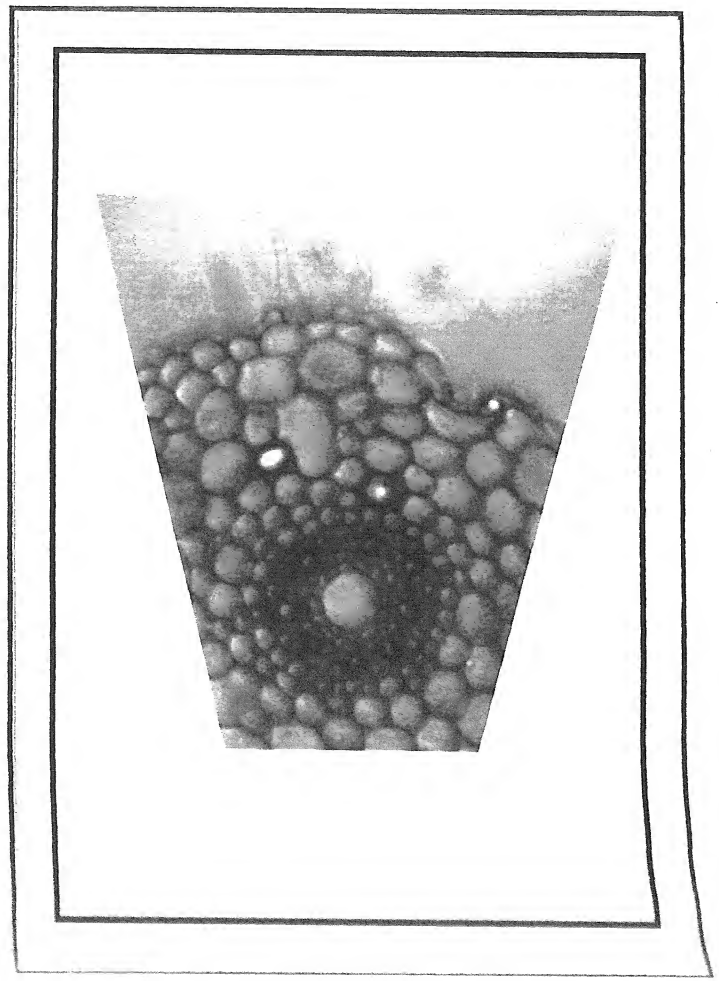
EFFECT ON DIAMETER OF ROOT :

Results given in Table-16 and Photo-9 show that treatments with 1 percent ether and 2 percent water extracts exercise increase in diameter of root over control. However, 1 percent ether extracts is comparatively more beneficial than water extract.

Results were statistically analysed following analysis of variance method and observed increase with 1 percent ether extract is significant at 5 percent error probability.

PHOTO - 9 : EFFECT OF 6 HOURS TREATMENT WITH EXTRACTS OF ***Spirodella polyrhiza*** ON WHEAT ROOT





EFFECT ON DIAMETER OF STELE :

Observations entered in Table-16 and Photo-9 show that treatments with 1 percent ether and 2 percent water extracts mark increase in diameter of stele over control. However, 1 percent ether extract is comparatively more stimulatory than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

EFFECT ON DIAMETER OF VASCULAR BUNDLES :

A perusal of Table-16 and Photo-9 shows that treatments with 1 percent ether and 2 percent water extracts exercise increase in diameter of vascular bundles over control. However, 1 percent ether extract exercises increase in diameter on vascular bundles to larger extent.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

EFFECT ON DIAMETER OF METAXYLEM :

An examination of Table-16 and Photo-9 shows that

treatments with 1 percent ether and 2 percent water extracts mark increase in diameter of metaxylem over control. However, 1 percent ether extract is comparatively more beneficial than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

EFFECT ON NUMBER OF PROTOXYLEM PER MICROSCOPIC FIELD :

Results given in Table-16 and Photo-9 show that treatments with 1 percent ether and 2 percent water extracts exercise increase in number of protoxylem per microscopic field over control. However, 1 percent ether extract is comparatively more stimulatory than water extract.

Results were statistically analysed following analysis of variance method and observed increase with 1 percent ether extract is significant at 5 percent error probability.

EFFECT ON NUMBER OF ROOT HAIR PER MICROSCOPIC FIELD :

Observations entered in Table-16 and Photo-9 show that treatments with 1 percent ether and 2 percent water extracts mark increase in number of root hair per microscopic field

over control. However, 1 percent ether extract more effectively increases number of root hair than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and 2 percent water extracts are insignificant at 5 percent error probability.

INFLUENCE OF 12 HRS PRE-SOAKING SEED TREATMENT ON ROOT :

EFFECT ON DIAMETER OF ROOT :

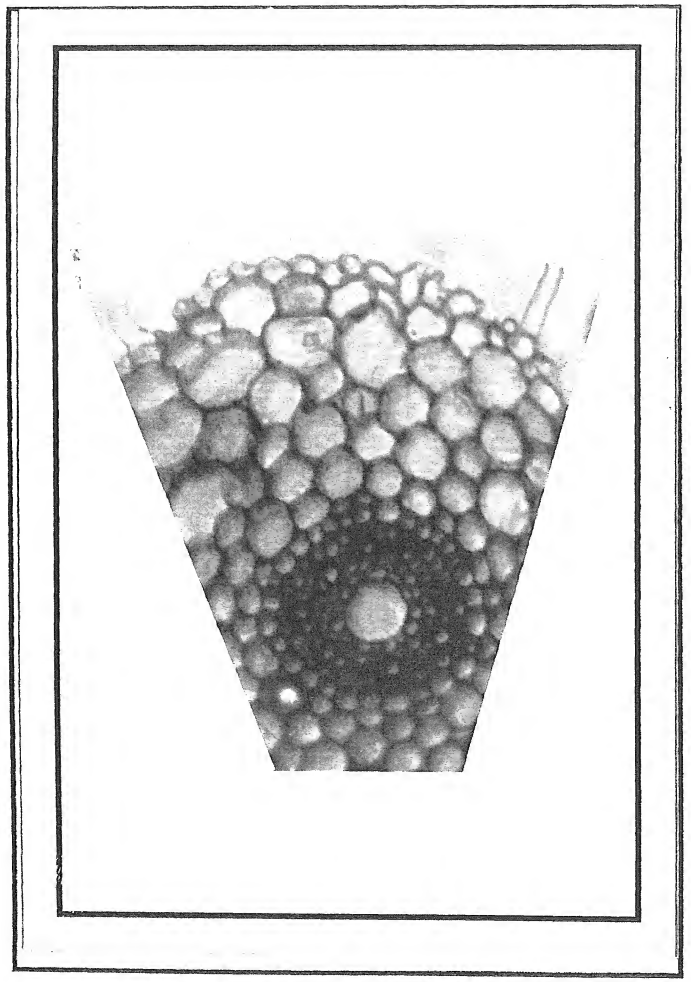
Observation given in Table-16 and Photo-10 exhibit that treatments with both 1 percent ether and water extracts exercise increase in diameter of root over control. However, 1 percent ether extract is comparatively more beneficial than water extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and water extracts are significant at 5 percent error probability

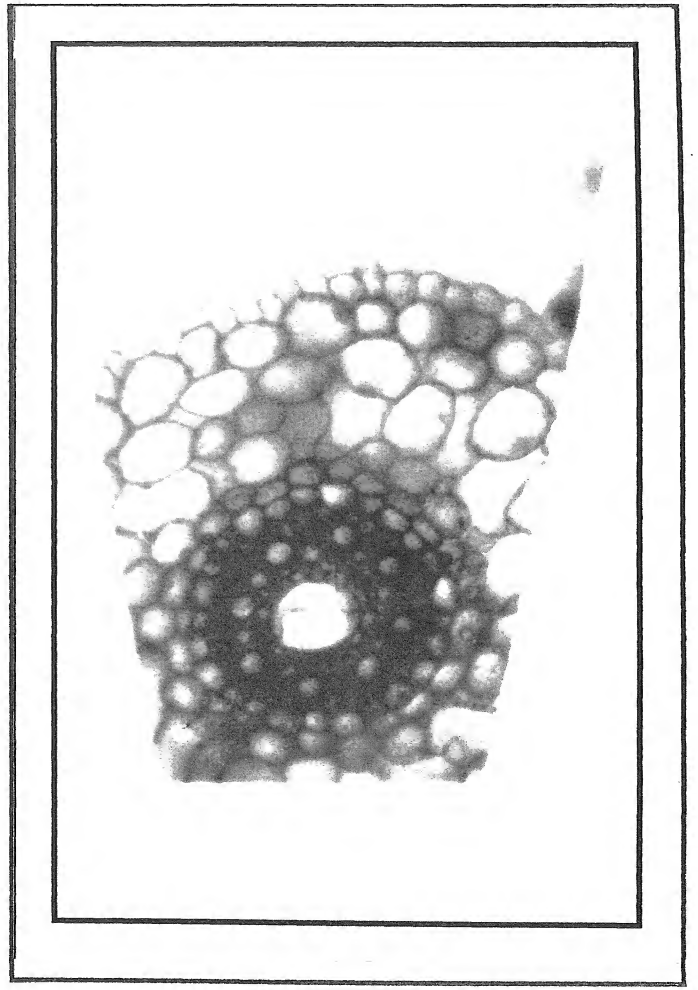
EFFECT ON DIAMETER OF STELE :

Results given in Table-16 and Photo-10 show that treatments with both 1 percent ether and water extracts exercise increase in diameter of stele over control. However,

PHOTO - 10 : EFFECT OF 12 HOURS TREATMENT WITH EXTRACTS OF ***Spirodella polyrhiza*** ON WHEAT ROOT



CONTROL



1 PERCENT ETHER WATER - EXTRACT

1 percent ether extract is comparatively more effective than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON DIAMETER OF VASCULAR BUNDLES :

A perusal of Table-16 and Photo-10 exhibits that treatments with both 1 percent ether and water extracts mark increase in diameter of vascular bundles over control. However, 1 percent ether extract is more stimulatory than water extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON DIAMETER OF METAXYLEM :

An examination of Table-16 and Photo-10 shows that treatments with both 1 percent ether and water extracts mark increase in diameter of metaxylem over control. However, 1 percent ether extract is more effective than water extract.

Statistical analysis of data shows that observed effect with 1 percent ether extract is significant at 5 percent error

probability.

EFFECT ON NUMBER OF PROTOXYLEM PER MICROSCOPIC FIELD :

Observations entered in Table-16 and Photo-10 exhibit that treatments with both 1 percent ether and water extracts exercise increase in number of protoxylem per microscopic field over control. However, 1 percent ether extract is more stimulatory than water extract.

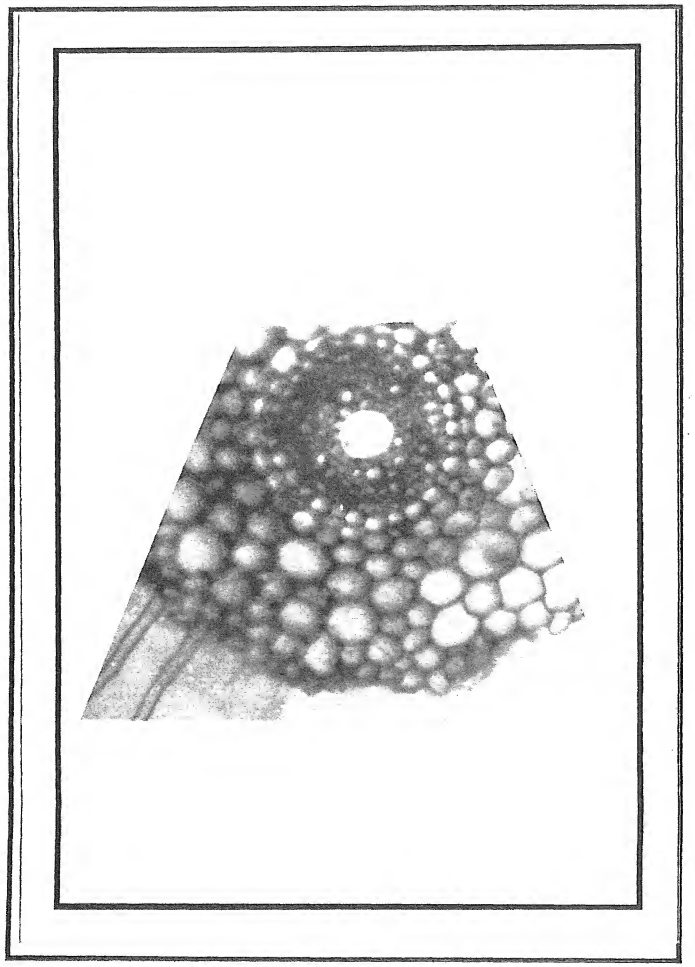
Results were statistically analysed following analysis of variance method and observed increase with 1 percent ether extract is significant at 5 percent error probability.

EFFECT ON NUMBER OF ROOT HAIR PER MICROSCOPIC FIELD :

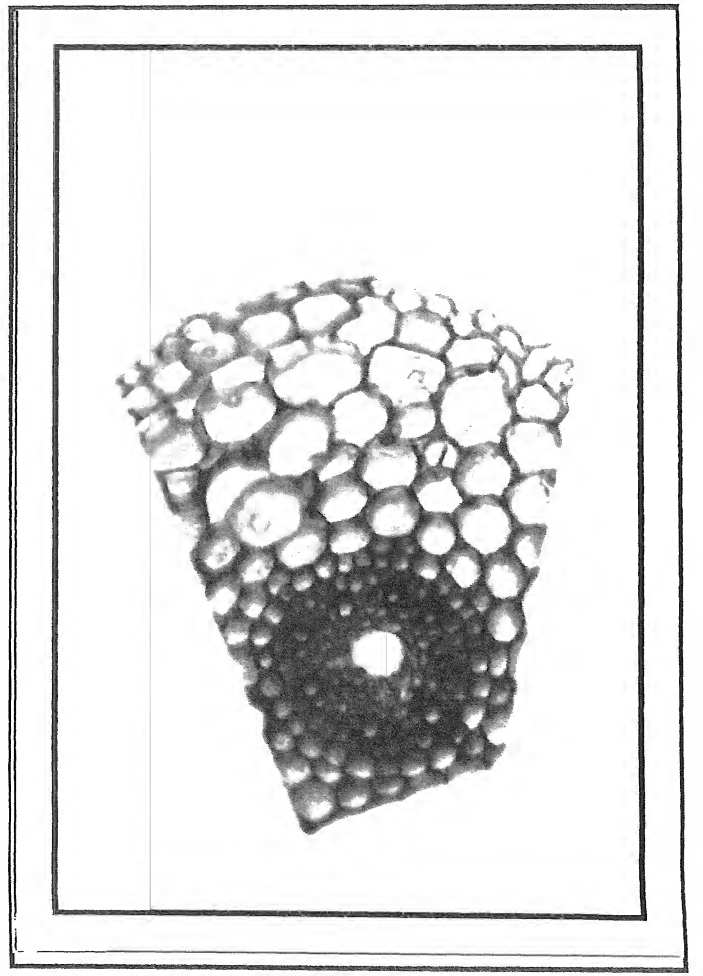
A perusal of Table-16 and Photo-10 shows that treatments with both 1 percent ether and water extracts exercise increase in number of root hair per microscopic field over control. However, 1 percent ether extract is comparatively more beneficial than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

PHOTO - 11 : EFFECT OF 24 HOURS TREATMENT WITH EXTRACTS OF ***Spirodella polyrhiza*** ON WHEAT ROOT



CONTROL



1 PERCENT ETHER WATER - EXTRACT

EFFECT ON DIAMETER OF VASCULAR BUNDLES :

A perusal of Table-16 and Photo-11 shows that treatments with 1 percent ether and water extracts mark increase in diameter of vascular bundles over control. However, 1 percent ether extract is comparatively more effective than water extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON DIAMETER OF METAXYLEM :

An examination of Table-16 and Photo-11 shows that treatments with 1 percent ether and water extracts exercise increase in diameter of metaxylem over control. However, 1 percent ether extract is comparatively more beneficial than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

TABLE - 16 : RESPONSE OF WHEAT ROOT TO PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACTS

SOAKING PERIOD	DIAMETER OF ROOT IN μ			DIAMETER OF STELE IN μ			DIAMETER OF V.B. IN μ			DIAMETER OF METAXYLEM IN μ			NO. OF PROTOXYLEM PER MICROSCOPIC FIELD			NO. OF ROOT HAIR PER MICROSCOPIC FIELD		
	C	1%EW	2% W	C	1%EW	2% W	C	1%EW	2%W	C	1%EW	2%W	C	1%EW	2%W	C	1%EW	2%W
6 HRS	698.45	760.01	718.94	242.66	285.49	254.12	203.13	225.86	219.51	65.28	72.56	68.91	14.91	17.63	15.45	31.81	33.61	33.00
	C	1%EW	1% W	C	1%EW	1% W	C	1%EW	1%W	C	1%EW	1%W	C	1%EW	1%W	C	1%EW	1%W
12 HRS	703.32	498.79	752.85	262.57	302.81	286.53	211.61	233.71	226.67	69.63	78.95	71.35	15.82	17.95	16.37	36.71	41.50	38.93
	C	1%EW	1% W	C	1%EW	1% W	C	1%EW	1%W	C	1%EW	1%W	C	1%EW	1%W	C	1%EW	1%W
24 HRS	643.98	715.28	691.39	226.34	258.62	238.12	198.11	218.68	211.31	56.03	65.26	60.73	14.02	16.81	15.31	30.39	32.51	31.11
	C.D. = 24.50 DIFFERENCE 6 HRS 1% EW-C = 61.56 2% W-C = 20.49			C.D. = 11:01 DIFFERENCE 6 HRS 1% EW-C = 42.83 2% W-C = 11.46			C.D. = 1.86 DIFFERENCE 6 HRS 1% EW-C = 22.73 2% W-C = 16.38			C.D. = 2.60 DIFFERENCE 6 HRS 1% EW-C = 7.28 2% W-C = 3.63			C.D. - 0.62 DIFFERENCE 6 HRS 1% EW-C = 2.72 2% W-C = 0.54			C.D. = 1.91 DIFFERENCE 6 HRS 1% EW-C = 1.80 2% W-C = 1.19		
	DIFFERENCE 12 HRS 1% EW-C = 95.47 1% W-C = 49.53			DIFFERENCE 12 HRS 1% EW-C = 40.24 1% W-C = 23.96			DIFFERENCE 12 HRS 1% EW-C = 22.10 1% W-C = 15.03			DIFFERENCE 12 HRS 1% EW-C = 9.32 1% W-C = 1.72			DIFFERENCE 12 HRS 1% EW-C = 2.13 1% W-C = 0.55			DIFFERENCE 12 HRS 1% EW-C = 4.79 1% W-C = 2.22		
	DIFFERENCE 24 HRS 1% EW-C = 71.30 1% W-C = 47.41			DIFFERENCE 24 HRS 1% EW-C = 32.28 1% W-C = 11.78			DIFFERENCE 24 HRS 1% EW-C = 20.57 1% W-C = 13.20			DIFFERENCE 24 HRS 1% EW-C = 9.23 1% W-C = 4.70			DIFFERENCE 24 HRS 1% EW-C = 2.79 1% W-C = 1.29			DIFFERENCE 24 HRS 1% EW-C = 2.12 1% W-C = 0.72		

ABBREVIATIONS USED : C - Control, EW - Ether-Water extract, W - Water extract, and C.D. - Critical Difference.

EFFECT ON NUMBER OF PROTOXYLEM PER MICROSCOPIC FIELD :

Observations entered in Table-16 and Photo-11 exhibit that treatments with 1 percent ether and water extracts exercise increase in number of protoxylem per microscopic field over control. However, 1 percent ether extract is comparatively more stimulatory than water extract.

Results were statistically analysed following analysis of variance method and observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON NUMBER OF ROOT HAIR PER MICROSCOPIC FIELD :

An examination of Table-16 and Photo-11 shows that treatments with 1 percent ether and water extracts mark increase in number of root hair per microscopic field over control. However, 1 percent ether extract is comparatively more beneficial than water extract.

Statistical analysis of data shows that observed increase with 1 percent ether extract is significant at 5 percent error probability.

INFLUENCE OF 6 HRS PRE-SOAKING SEED TREATMENT ON STEM :

EFFECT ON DIAMETER OF XYLEM TISSUE :

Results given in Table-17 and Photo-12 show that treatments with 1 percent ether and 2 percent water extracts exercise increase in diameter of xylem tissue over control. However, 1 percent ether extract exercises more marked effect than water extract.

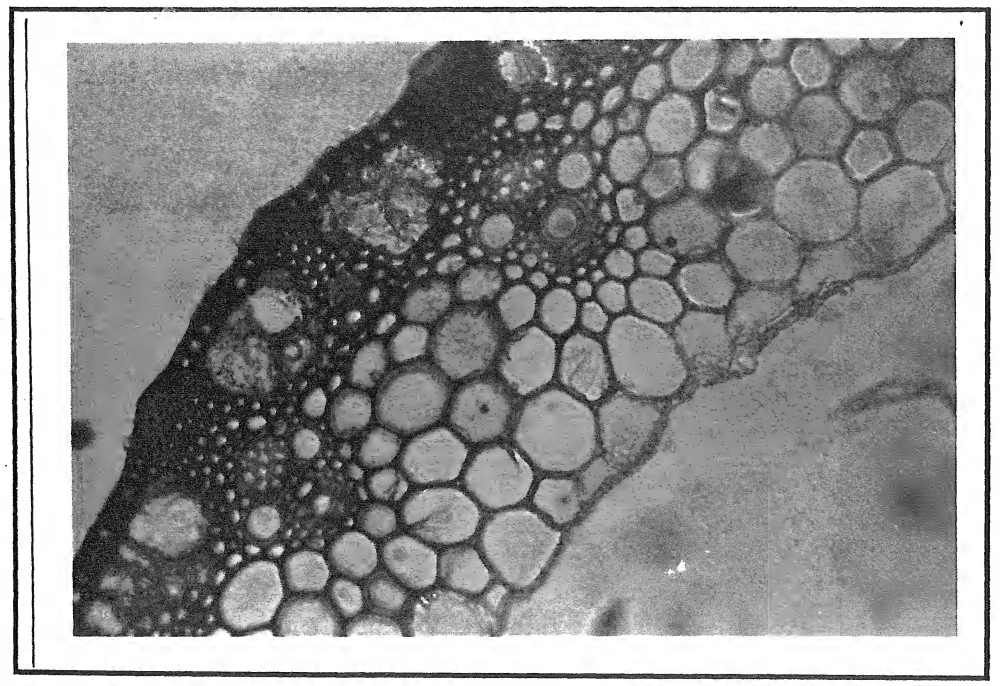
Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

EFFECT ON DIAMETER OF PHLOEM :

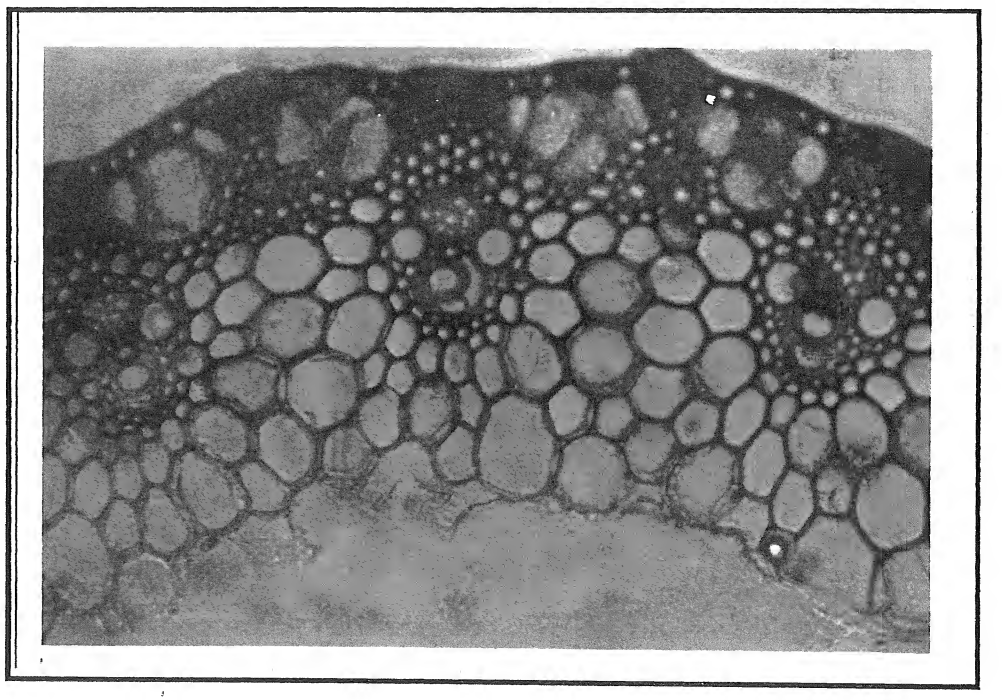
Observations entered in Table-17 and Photo-12 show that treatments with 1 percent ether and 2 percent water extracts mark increase in diameter of phloem over control. However, 1 percent ether extract is comparatively more stimulatory than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and 2 percent water extracts are insignificant at 5 percent error probability.

PHOTO - 12 : EFFECT OF 6 HOURS TREATMENT WITH EXTRACTS OF ***Spirodella polyrhiza*** ON WHEAT STEM



CONTROL



1 PERCENT ETHER - WATER EXTRACT

EFFECT ON DIAMETER OF STEM :

A perusal of Table-17 and Photo-12 shows that treatments with 1 percent ether and 2 percent water extracts mark increase in diameter of stem over control. However, 1 percent ether extract is comparatively more beneficial than water extract.

Results were statistically analysed following analysis of variance method and observed increase with 1 percent ether extract is significant at 5 percent error probability.

EFFECT ON DIAMETER OF METAXYLEM :

An examination of Table-17 and Photo-12 exhibits that treatments with 1 percent ether and 2 percent water extracts exercise increase in diameter of metaxylem over control. However, 1 percent ether extract is more effective than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

EFFECT ON DIAMETER OF PROTOXYLEM :

Results given in Table-17 and Photo-12 show that treatments with 1 percent ether and 2 percent water extracts

exercise increase in diameter of protoxylem over control. However, 1 percent ether extract exercises more marked effect than water extract.

Results were statistically analysed and observed effects with both 1 percent ether and 2 percent water extracts are insignificant at 5 percent error probability.

EFFECT ON NUMBER OF VASCULAR BUNDLES PER MICROSCOPIC FIELD :

Observations entered in Table-17 and Photo-12 show that treatments with 1 percent ether and 2 percent water extracts mark increase in number of vascular bundles per microscopic field over control. However, 1 percent ether extract is comparatively more effective than water extract.

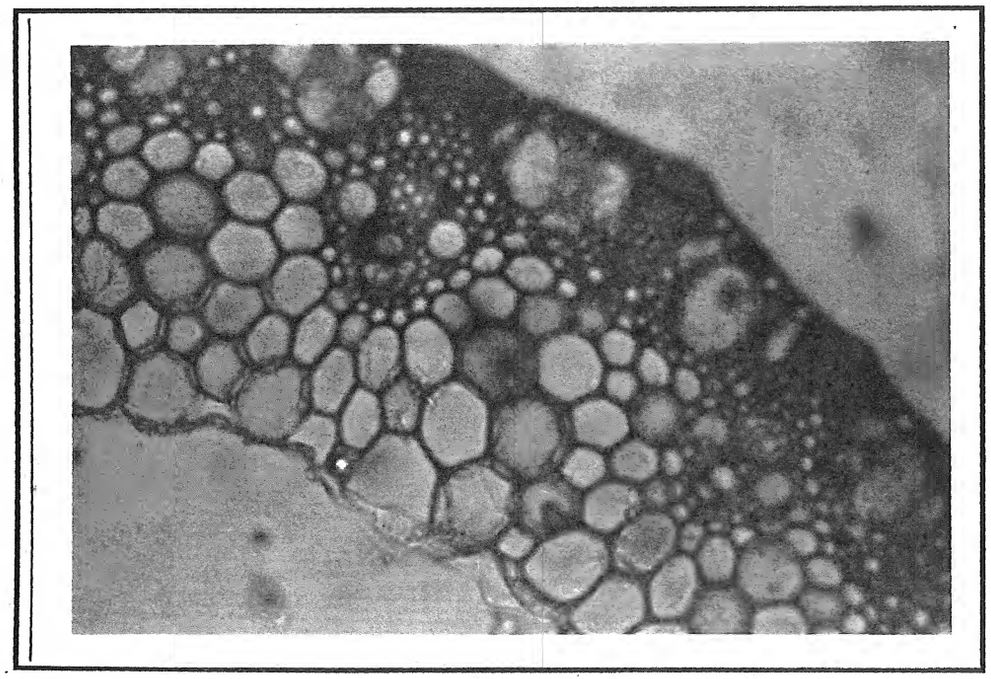
Statistical analysis of data shows that observed increases with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

INFLUENCE OF 12 HRS PRE-SOAKING SEED TREATMENT ON STEM :

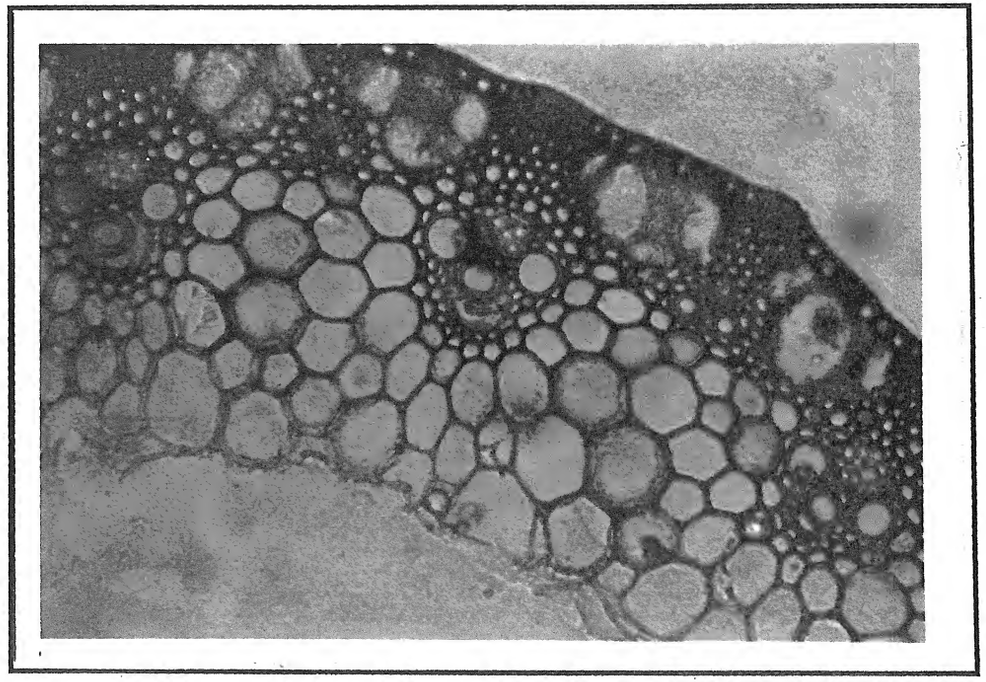
EFFECT ON DIAMETER OF XYLEM TISSUE :

Observations given in Table-17 and Photo-13 exhibit that treatments with 1 percent ether and water extracts

PHOTO - 13 : EFFECT OF 12 HOURS TREATMENT WITH EXTRACTS OF ***Spirodella polyrhiza*** ON WHEAT STEM



CONTROL



1 PERCENT ETHER - WATER EXTRACT

exercise increase in diameter of xylem tissue over control. However, 1 percent ether extract is comparatively more beneficial than water extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON DIAMETER OF PHLOEM :

Results given in Table-17 and Photo-13 show that treatments with 1 percent ether and water extracts exercise increase in diameter of phloem over control. However, 1 percent ether extract is comparatively more effective than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON DIAMETER OF STEM :

A perusal of Table-17 and Photo-13 exhibits that treatments with 1 percent ether and water extracts mark increase in diameter of stem over control. However, 1 percent ether extract is comparatively more stimulatory than water extract.

Results were statistically analysed and observed increases with both 1 percent ether and 1 percent water extracts are insignificant at 5 percent error probability.

EFFECT ON DIAMETER OF METAXYLEM :

An examination of Table-17 and Photo-13 shows that treatments with 1 percent ether and water extracts exercise increase in diameter of metaxylem over control. However, 1 percent ether extract is comparatively more effective than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON DIAMETER OF PROTOXYLEM :

Observations entered in Table-17 and Photo-13 exhibit that treatments with 1 percent ether and water extracts exercise increase in diameter of protoxylem over control. However, 1 percent ether extract is comparatively more stimulatory than water extract.

Results were statistically analysed and observed increase with 1 percent ether extract is significant at 5 percent error probability.

EFFECT ON NUMBER OF VASCULAR BUNDLES PER MICROSCOPIC FIELD :

A perusal of Table-17 and Photo-13 shows that treatments with 1 percent ether and water extracts exercise increase in number of vascular bundles per microscopic field over control. However, 1 percent ether extract is more stimulatory than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

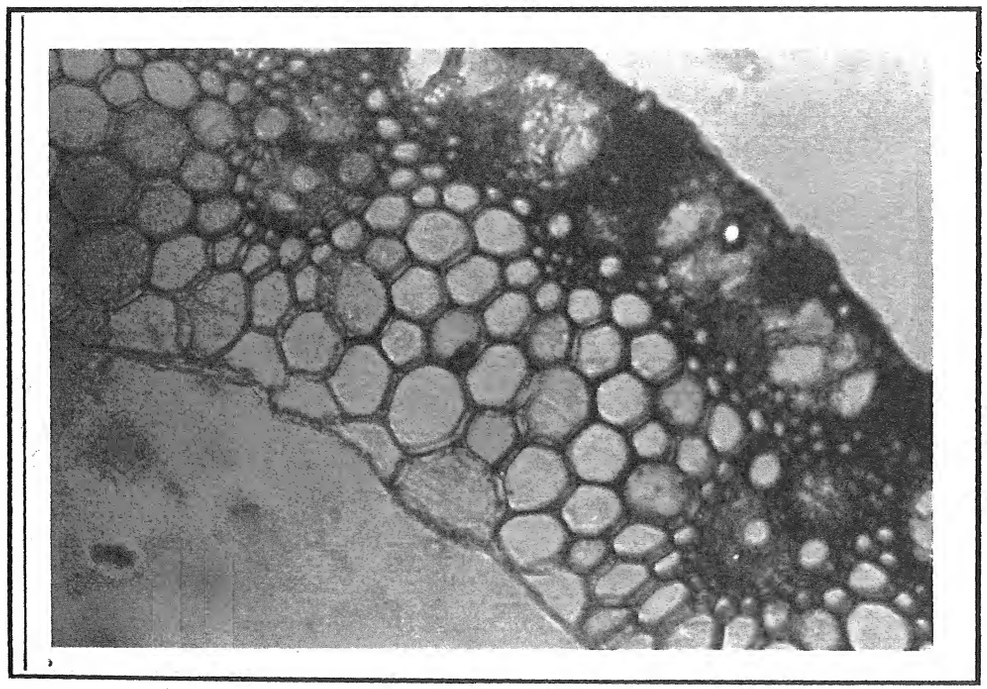
INFLUENCE OF 24 HRS PRE-SOAKING SEED TREATMENT ON STEM :

EFFECT ON DIAMETER OF XYLEM TISSUE :

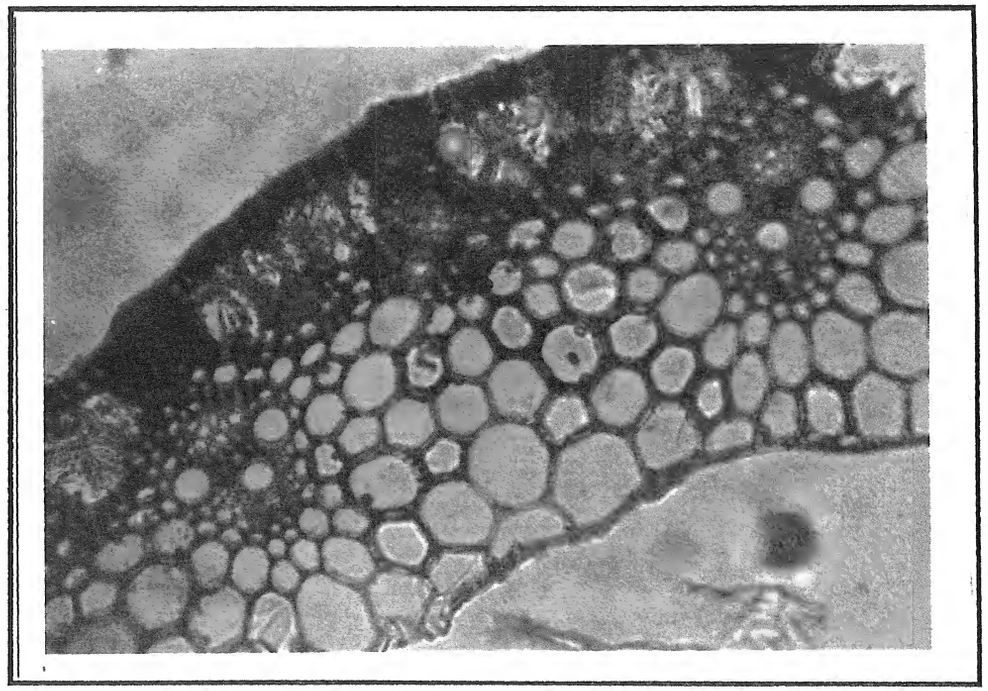
Results given in Table-17 and Photo-14 show that treatments with 1 percent ether and water extracts exercise increase in diameter of xylem tissue over control. However, 1 percent ether extract is more effective than water extract.

Results were statistically analysed and observed increases with both 1 percent ether and water extracts are significant at 5 percent error probability.

PHOTO - 14 : EFFECT OF 24 HOURS TREATMENT WITH EXTRACTS OF ***Spirodella polyrhiza*** ON WHEAT STEM



CONTROL



1 PERCENT ETHER - WATER EXTRACT

EFFECT ON DIAMETER OF PHLOEM :

Observations entered in Table-17 and Photo-14 exhibit that treatment with 1 percent ether and water extracts mark increase in diameter of phloem over control. However, 1 percent ether extract is comparatively more stimulatory than water extract.

Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON DIAMETER OF STEM :

A perusal of Table-17 and Photo-14 shows that treatments with 1 percent ether and water extracts mark increase in diameter of stem. However, 1 percent ether extract is comparatively more effective than water extract.

Results were statistically analysed and observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON DIAMETER OR METAXYLEM :

An examination of Table-17 and Photo-14 exhibits that treatments with 1 percent ether and water extracts exercise increase in diameter of metaxylem over control. However, 1

percent ether extract is more stimulatory than water extract.

Statistical analysis of data shows that observed increases with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON DIAMETER OF PROTOXYLEM :

Observations entered in Table-17 and Photo-14 exhibit that treatments with 1 percent ether and water extracts exercise increase in diameter of protoxylem over control. However, 1 percent ether extract is comparatively more stimulatory than water extract.

Results were statistically analysed and observed increases with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON NUMBER OF VASCULAR BUNDLES PER MICROSCOPIC FIELD :

An examination of Table-17 and Photo-14 shows that treatments with 1 percent ether and water extracts mark increase in number of vascular bundles per microscopic field over control. However, 1 percent ether extract is comparatively more beneficial than water extract.

TABLE - 17 : RESPONSE OF WHEAT STEM TO PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACTS

SOAKING PERIOD	DIAMETER OF XYLEM TISSUE IN μ			DIAMETER OF PHLOEM IN μ			DIAMETER OF STEM IN μ			DIAMETER OF METAXYLEM IN μ			DIAMETER OF PROTOXYLEM IN μ			NO. OF V. B. PER MICROSCOPIC FIELD		
	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2% W
6 HRS	76.50	94.11	85.18	32.54	39.09	34.33	2882.12	3281.71	3106.81	34.50	44.15	42.22	28.38	30.17	29.43	8.32	11.64	10.21
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W
12 HRS	79.28	98.31	86.39	35.84	44.26	38.67	3163.31	3528.68	3511.03	38.62	45.11	43.18	29.83	32.41	30.63	9.58	12.25	11.31
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1% W
24 HRS	65.61	82.76	76.42	26.34	34.75	30.64	2225.63	3101.44	3000.36	31.71	42.34	37.51	25.52	29.95	29.12	8.13	11.44	9.72
	C.D. = 3.23 DIFFERENCE 6 HRS 1% EW-C = 17.61 2% W-C = 8.68			C.D. = 1.71 DIFFERENCE 6 HRS 1% EW-C = 6.47 2% W-C = 1.79			C.D. = 382.58 DIFFERENCE 6 HRS 1% EW-C = 399.89 2% W-C = 224.69			C.D. = 2.93 DIFFERENCE 6 HRS 1% EW-C = 9.65 2% W-C = 7.72			C.D. - 1.98 DIFFERENCE 6 HRS 1% EW-C = 1.79 2% W-C = 1.05			C.D. = 0.52 DIFFERENCE 6 HRS 1% EW-C = 3.32 2% W-C = 1.89		
	DIFFERENCE 12 HRS 1% EW-C = 19.03 1% W-C = 7.11			DIFFERENCE 12 HRS 1% EW-C = 8.42 1% W-C = 2.83			DIFFERENCE 12 HRS 1% EW-C = 365.37 1% W-C = 347.72			DIFFERENCE 12 HRS 1% EW-C = 6.49 1% W-C = 4.56			DIFFERENCE 12 HRS 1% EW-C = 2.58 1% W-C = 0.80			DIFFERENCE 12 HRS 1% EW-C = 2.67 1% W-C = 1.73		
	DIFFERENCE 24 HRS 1% EW-C = 17.15 1% W-C = 10.81			DIFFERENCE 24 HRS 1% EW-C = 8.41 1% W-C = 4.30			DIFFERENCE 24 HRS 1% EW-C = 875.81 1% W-C = 774.73			DIFFERENCE 24 HRS 1% EW-C = 10.63 1% W-C = 5.80			DIFFERENCE 24 HRS 1% EW-C = 4.43 1% W-C = 3.60			DIFFERENCE 24 HRS 1% EW-C = 3.31 1% W-C = 1.59		

ABBREVIATIONS USED : C - Control, EW - Ether-Water extract, W - Water extract, and C.D. - Critical Difference.

Statistical analysis of data shows that observed effects with both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON UPPER EPIDERMIS

INFLUENCE OF 6 HRS PRE-SOAKING SEED TREATMENT ON EPIDERMAL CELLS :

NUMBER OF EPIDERMAL CELLS PER MICROSCOPIC FIELD :

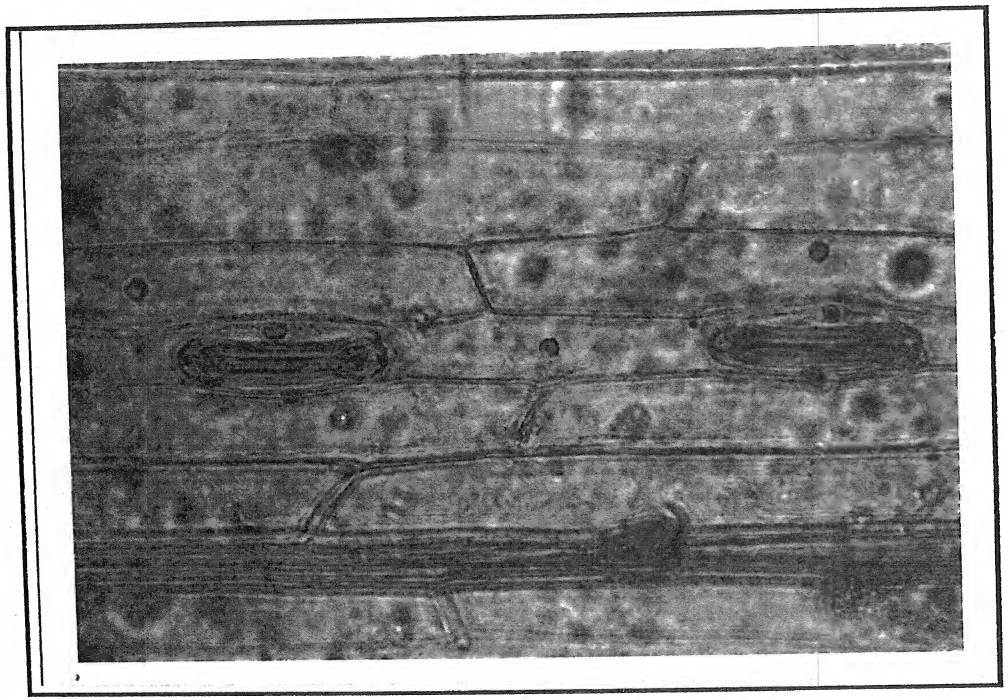
Observations entered in Table-18 and Photo-15 show that treatments with 1 percent ether and 2 percent water extracts exercise increase in number of epidermal cells per microscopic field over control. However, effect of 1 percent ether extract is comparatively more pronounced than 2 percent water extract.

Results were statistically analysed and observed increases with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

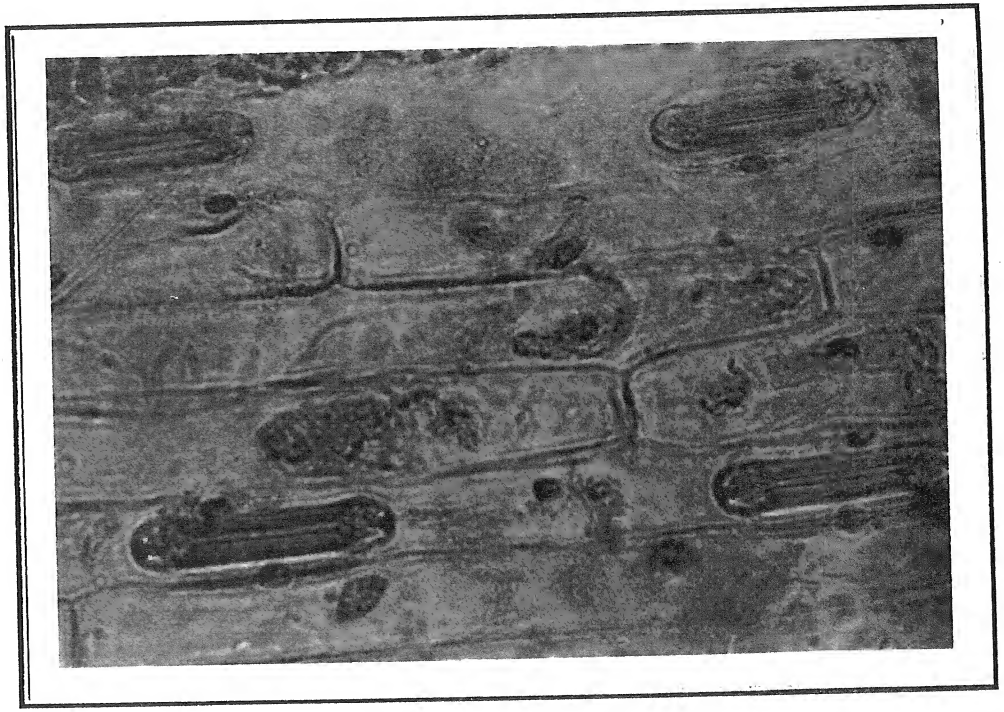
NUMBER OF STOMATA PER MICROSCOPIC FIELD :

Results given in Table-18 and Photo-15 mark that treatments with 1 percent ether and 2 percent water extracts exercise a stimulatory effect on number of stomata per microscopic field over control. However, effect of 1 percent ether extract is comparatively more marked than 2 percent water extract.

PHOTO - 15 : EFFECT OF 6 HOURS TREATMENT WITH ***Spirodella polyrhiza*** EXTRACTS ON UPPER EPIDERMAL STRUCTURE OF WHEAT LEAF



CONTROL



1 PERCENT ETHER - WATER EXTRACT

Results were statistically analysed and observed increases with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

LENGTH OF EPIDERMAL CELL :

A perusal of Table-18 and Photo-15 shows that treatments with 1 percent ether and 2 percent water extracts exercise an increase in length of epidermal cell over control. However, influence of 1 percent ether extract is comparatively more pronounced than 2 percent water extract.

Statistical analysis of data shows that observed effects of both 1 percent ether and 2 percent water extracts are insignificant at 5 percent error probability.

BREADTH OF EPIDERMAL CELL :

An examination of Table-18 and Photo-15 marks that treatments with 1 percent ether and 2 percent water extracts exercise an increase in breadth of epidermal cells over control. However, effect of 1 percent ether extract is more marked than 2 percent water extract.

Results were statistically analysed and observed increase with 1 percent ether extract is significant at 5 percent error probability.

PERIMETER OF STOMATAL PORE :

Observations given in Table-18 and Photo-15 show that treatments with 1 percent ether and 2 percent water extracts exercise increase in perimeter of stomatal pore over control. However, effect of 1 percent ether extract is comparatively more pronounced than 2 percent water extract.

Statistical analysis of data shows that observed effects of both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

LENGTH OF GUARD CELLS :

Results given in Table-18 and Photo-15 mark that treatments with 1 percent ether and 2 percent water extracts exercise an increase in length of guard cells over control. However, influence of 1 percent ether extract is comparatively more marked than 2 percent water extract.

Results were statistically analysed and observed increases with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

BREADTH OF GUARD CELLS :

An examination of Table-18 and Photo-15 marks that treatments with 1 percent ether and 2 percent water extracts

exercise an increase in breadth of guard cells over control. However, influence of 1 percent ether extract is comparatively more pronounced than 2 percent water extract.

Statistical analysis of data shows that observed effects of both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

INFLUENCE OF 12 HRS PRE-SOAKING SEED TREATMENT ON EPIDERMAL CELLS :

NUMBER OF EPIDERMAL CELLS PER MICROSCOPIC FIELD :

Observations entered in Table-18 and Photo-16 show that there is an increase in number of epidermal cells per microscopic field under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more stimulatory towards increasing number of epidermal cells as compared to water extract.

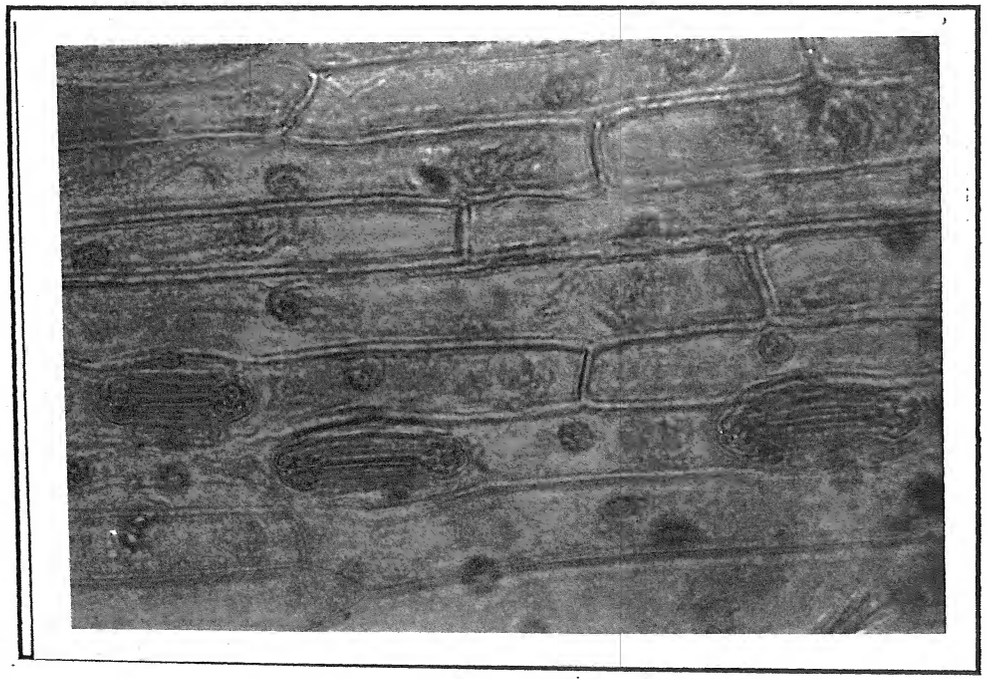
Statistical analysis of data shows that observed effects of both 1 percent ether and water extracts are significant at 5 percent error probability.

NUMBER OF STOMATA PER MICROSCOPIC FIELD :

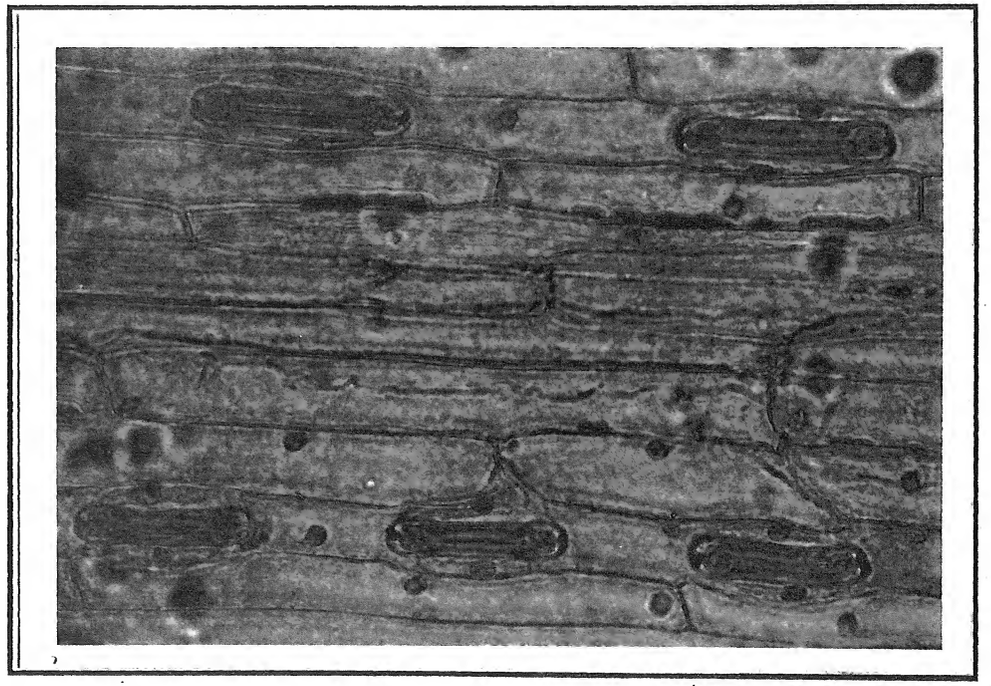
Results entered in Table-18 and Photo-16 show that there is an increase in number of stomata per microscopic field under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more effective in increasing number of stomata as compared to water extract.

Results were statistically analysed and observed effects of both 1 percent ether and water extracts are significant at 5 percent error probability.

PHOTO - 16 : EFFECT OF 12 HOURS TREATMENT WITH ***Spirodella polyrhiza*** EXTRACTS ON UPPER EPIDERMAL STRUCTURE OF WHEAT LEAF



CONTROL



1 PERCENT ETHER - WATER EXTRACT

LENGTH OF EPIDERMAL CELL :

An examination of Table-18 and Photo-16 marks that there is an increase in length of epidermal cells under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract increases length of epidermal cells to larger extent as compared to water extract.

Statistical analysis of data shows that observed effects of both 1 percent ether and water extracts are significant at 5 percent error probability.

BREADTH OF EPIDERMAL CELL :

A perusal of Table-18 and Photo-16 shows that there is an increase in breadth of epidermal cells under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more effective in increasing breadth of epidermal cell as compared to water extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and water extracts are significant at 5 percent error probability.

PERIMETER OF STOMATAL PORE :

Observations given in Table-18 and Photo-16 shows that there is an increase in perimeter of stomatal pore treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more stimulatory in increasing perimeter of stomatal pore as compared to water extract.

Statistical analysis of data shows that observed effects of both 1 percent ether and water extracts are significant at 5 percent error probability.

LENGTH OF GUARD CELLS :

Results entered in Table-18 and Photo-16 mark that there is an increase in length of guard cells under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more effective as compared to water extract.

Results were statistically analysed and observed effects of both 1 percent ether and water extracts are significant at 5 percent error probability.

BREADTH OF GUARD CELLS :

An examination of Table-18 and Photo-16 shows that there is an increase in breadth of guard cells under treatments

with both 1 percent ether and water extracts. However, 1 percent ether extract is more stimulatory as compared to water extract.

Statistical analysis of data shows that observed effects of both 1 percent ether and water extracts are significant at 5 percent error probability.

INFLUENCE OF 24 HRS PRE-SOAKING SEED TREATMENT ON EPIDERMAL CELLS :

NUMBER OF EPIDERMAL CELLS PER MICROSCOPIC FIELD :

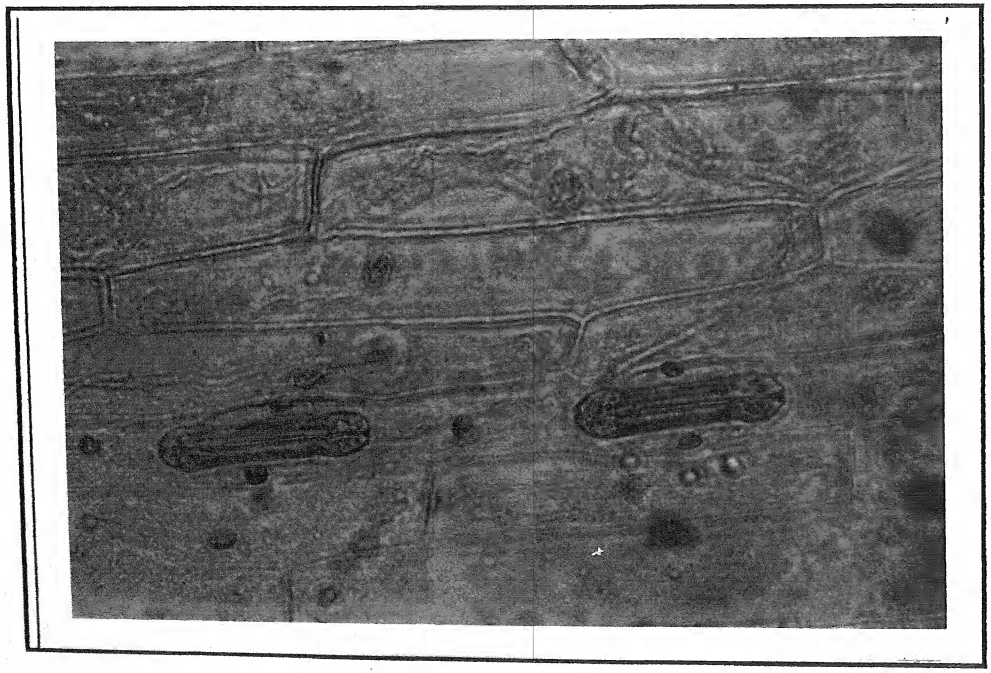
Observations entered in Table-18 and Photo-17 show that there is an increase in number of epidermal cells per microscopic field under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more stimulatory as compared to water extract.

Statistical analysis of data shows that observed effect of 1 percent ether extract is significant at 5 percent error probability.

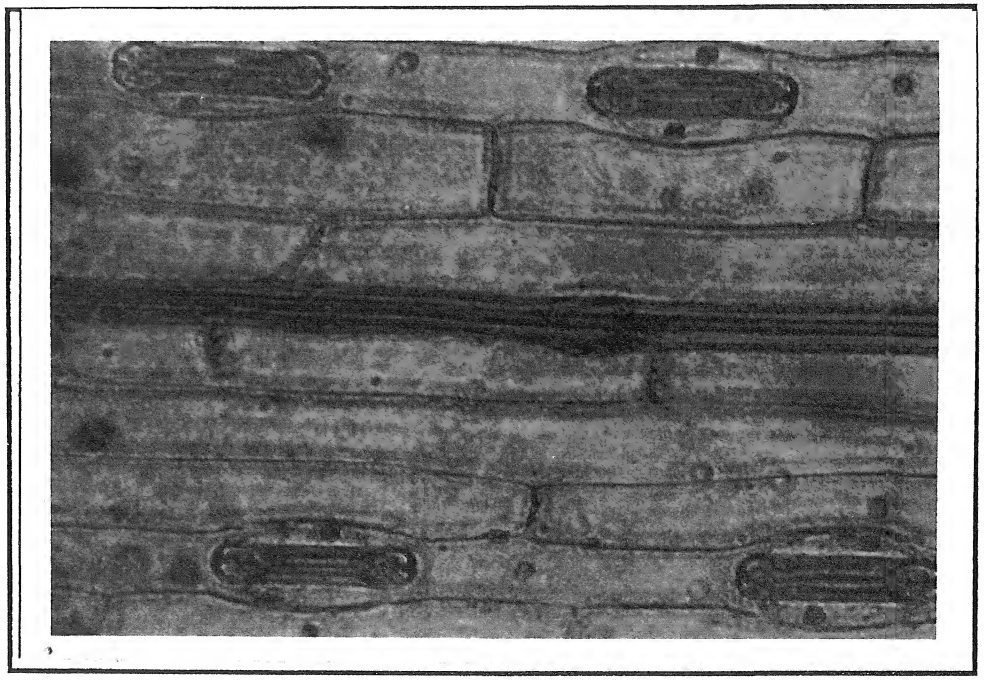
NUMBER OF STOMATA PER MICROSCOPIC FIELD :

Results entered in Table-18 and Photo-17 show that there is an increase in number of stomata per microscopic

PHOTO - 17 : EFFECT OF 24 HOURS TREATMENT WITH ***Spirodella polyrhiza*** EXTRACTS ON UPPER EPIDERMAL STRUCTURE OF WHEAT LEAF



CONTROL



1 PERCENT ETHER - WATER EXTRACT

field under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more effective in increasing number of stomata as compared to water extract.

Results were statistically analysed and observed effects of both 1 percent ether and water extracts are significant at 5 percent error probability.

LENGTH OF EPIDERMAL CELL :

An examination of Table-18 and Photo-17 marks that there is an increase in length of epidermal cells under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more effective than water extract.

Statistical analysis of data shows that observed increases with both 1 percent ether and water extracts are insignificant at 5 percent error probability.

BREADTH OF EPIDERMAL CELL :

A perusal of Table-18 and Photo-17 shows that there is an increase in breadth of epidermal cells under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more effective as compared to water extract.

Results were statistically analysed and observed increase with 1 percent ether extract is significant at 5 percent error probability.

PERIMETER OF STOMATAL PORE :

Observations given in Table-18 and Photo-17 show that there is an increase in perimeter of stomatal pore under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more stimulatory in increasing perimeter of stomatal pore as compared to water extract.

Statistical analysis of data shows that observed effect of 1 percent ether extract is significant at 5 percent error probability.

LENGTH OF GUARD CELLS :

Results entered in Table-18 and Photo-17 indicate that there is an increase in length of guard cells under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more effective as compared to water extract.

Results were statistically analysed and observed effects of both 1 percent ether and water extracts are significant at 5 percent error probability.

TABLE - 18 : RESPONSE OF UPPER LEAF EPIDERMIS OF WHEAT TO PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACTS

SOAKING PERIOD	NO. OF EPIDERMAL CELLS PER MICROSCOPIC FIELD			NO. OF STOMATA PER MICROSCOPIC FIELD			LENGTH OF EPIDERMAL CELL IN μ			BREADTH OF EPIDERMAL CELL IN μ			PERIMETER OF STOMATAL PORE IN μ			LENGTH OF GUARD CELLS IN μ			BREADTH OF GUARD CELLS IN μ		
	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2%W	C	1%EW	2%W	C	1%EW	2%W	C	1% EW	2% W	C	1% EW	2% W
6 HRS	23.15	26.41	24.25	2.98	4.79	3.84	305.21	354.11	321.50	29.84	34.37	31.20	28.65	33.44	31.53	81.71	90.62	86.93	5.53	7.88	6.76
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1%W	C	1% EW	1%W	C	1%EW	1%W	C	1% EW	1% W	C	1% EW	1% W
12 HRS	25.51	28.01	26.73	3.74	5.48	4.55	318.27	465.35	418.64	32.67	39.04	36.52	30.51	37.84	34.32	84.28	93.56	89.19	6.63	8.26	7.48
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1%W	C	1% EW	1%W	C	1%EW	1%W	C	1% EW	1% W	C	1% EW	1% W
24 HRS	21.32	22.81	22.11	2.17	3.81	3.70	293.91	322.15	314.87	29.21	32.74	30.26	28.17	31.91	2.27	79.15	88.32	82.47	5.20	7.31	6.12
	C.D. = 1.09			C.D. = 0.58			C.D. = 75.54			C.D. = 1.98			C.D. - 2.26			C.D. = 1.40			C.D. = 0.44		
	DIFFERENCE 6 HRS 1% EW-C = 3.26 2% W-C = 1.10			DIFFERENCE 6 HRS 1% EW-C = 1.81 2% W-C = 0.86			DIFFERENCE 6 HRS 1% EW-C = 48.90 2% W-C = 16.29			DIFFERENCE 6 HRS 1% EW-C = 4.53 2% W-C = 1.36			DIFFERENCE 6 HRS 1% EW-C = 4.79 2% W-C = 2.88			DIFFERENCE 6 HRS 1% EW-C = 8.91 2% W-C = 5.22			DIFFERENCE 6 HRS 1% EW-C = 2.35 2% W-C = 1.23		
	DIFFERENCE 12 HRS 1% EW-C = 2.50 1% W-C = 1.22			DIFFERENCE 12 HRS 1% EW-C = 1.74 1% W-C = 0.81			DIFFERENCE 12 HRS 1% EW-C = 147.08 1% W-C = 100.37			DIFFERENCE 12 HRS 1% EW-C = 6.37 1% W-C = 3.85			DIFFERENCE 12 HRS 1% EW-C = 7.33 1% W-C = 3.81			DIFFERENCE 12 HRS 1% EW-C = 9.28 1% W-C = 4.91			DIFFERENCE 12 HRS 1% EW-C = 1.63 1% W-C = 0.85		
	DIFFERENCE 24 HRS 1% EW-C = 1.49 1% W-C = 0.79			DIFFERENCE 24 HRS 1% EW-C = 1.64 1% W-C = 1.53			DIFFERENCE 24 HRS 1% EW-C = 28.24 1% W-C = 20.96			DIFFERENCE 24 HRS 1% EW-C = 3.53 1% W-C = 1.05			DIFFERENCE 24 HRS 1% EW-C = 3.74 1% W-C = 1.10			DIFFERENCE 24 HRS 1% EW-C = 9.17 1% W-C = 3.32			DIFFERENCE 24 HRS 1% EW-C = 2.11 1% W-C = 0.92		

ABBREVIATIONS USED : C - Control, EW - Ether-Water extract, W - Water extract, and C.D. - Critical Difference.

BREADTH OF GUARD CELLS :

An examination of Table-18 and Photo-17 shows that there is an increase in breadth of guard cells under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more pronounced than water extract.

Statistical analysis of data shows that observed effects of both 1 percent ether and water extracts are significant at 5 percent error probability.

EFFECT ON LOWER EPIDERMIS

INFLUENCE OF 6 HRS PRE-SOAKING SEED TREATMENT ON EPIDERMAL CELLS :

NUMBER OF EPIDERMAL CELLS PER MICROSCOPIC FIELD :

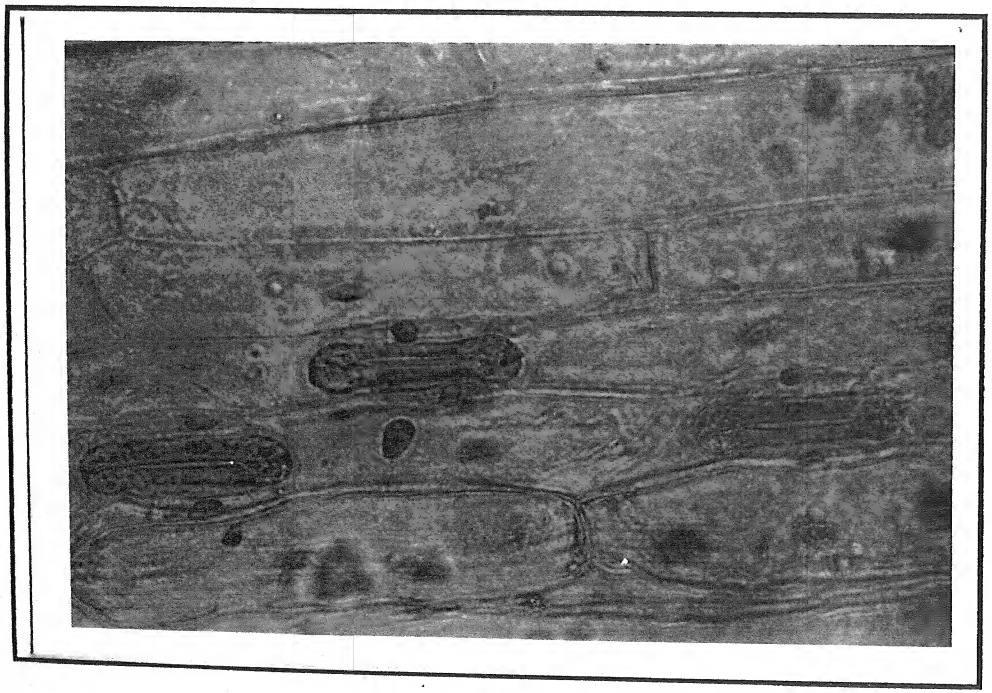
Observations entered in Table-19 and Photo-18 show that treatments with 1 percent ether and 2 percent water extracts exercise increase in number of epidermal cells per microscopic field over control. However, effect of 1 percent ether extract is comparatively more pronounced than 2 percent water extract.

Results were statistically analysed following analysis of variance method and observed effects of both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

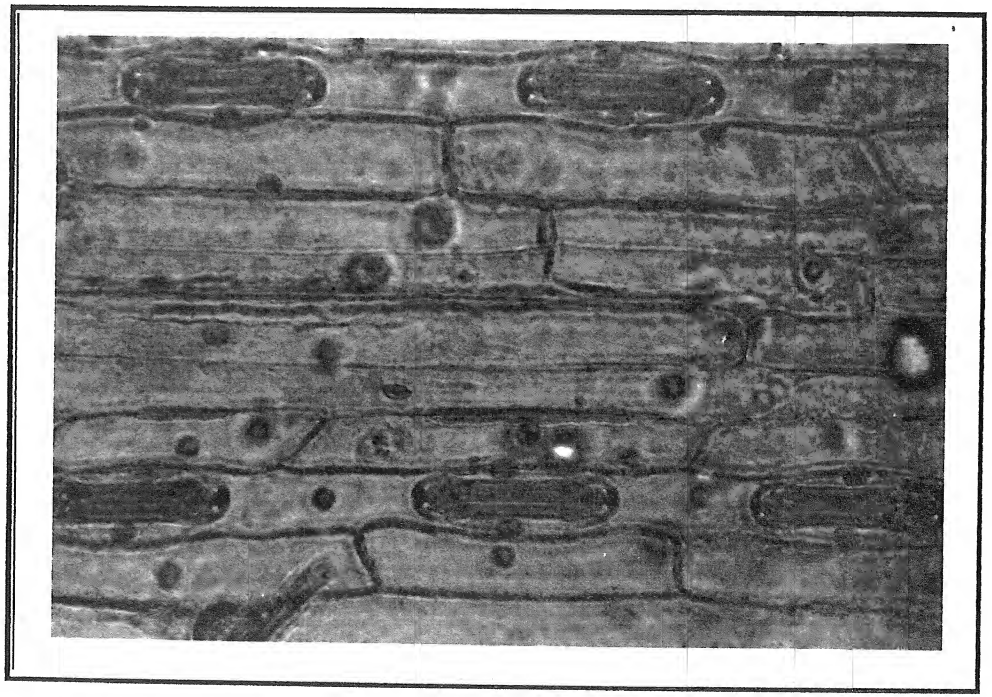
NUMBER OF STOMATA PER MICROSCOPIC FIELD :

Results given in Table-19 and Photo-18 suggest that treatments with 1 percent ether and 2 percent water extracts exercise a stimulatory effect towards increase in number of stomata per microscopic field over control. However, effect of 1 percent ether extract is comparatively more marked than

PHOTO - 18 : EFFECT OF 6 HOURS TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON LOWER EPIDERMAL STRUCTURE OF WHEAT LEAF



CONTROL



1 PERCENT ETHER - WATER EXTRACT

2 percent water extract.

Statistical analysis of data shows that observed effects of both 1 percent ether and 2 percent water extracts are insignificant at 5 percent error probability.

LENGTH OF EPIDERMAL CELL :

A perusal of Table-19 and Photo-18 shows that treatments with 1 percent ether and 2 percent water extracts exercise an increase in length of epidermal cells over control. However, influence of 1 percent ether extract is comparatively more pronounced than 2 percent water extract.

Statistical analysis of data shows that observed effects of both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

BREADTH OF EPIDERMAL CELL :

An examination of Table-19 and Photo-18 shows that treatments with 1 percent ether and 2 percent water extracts exercise increase in breadth of epidermal cells over control. However, effect of 1 percent ether extract is more pronounced than 2 percent water extract.

Results were statistically analysed and observed increases with both 1 percent ether and 2 percent water extracts are

significant at 5 percent error probability.

PERIMETER OF STOMATAL PORE :

Observations given in Table-19 and Photo-18 show that treatments with 1 percent ether and 2 percent water extracts increases in perimeter of stomatal pore over control. However, effect of 1 percent ether extract is comparatively more pronounced than 2 percent water extract.

Statistical analysis of data shows that observed effects of both 1 percent ether and 2 percent water extracts are insignificant at 5 percent error probability.

LENGTH OF GUARD CELLS :

Results given in Table-19 and Photo-18 indicate that treatments with 1 percent ether and 2 percent water extracts exercise an increase in length of guard cells over control. However, influence of 1 percent ether extract is comparatively more marked than 2 percent water extract.

Results were statistically analysed and observed increases with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

BREADTH OF GUARD CELLS :

An examination of Table-19 and Photo-18 shows that treatments with 1 percent ether and 2 percent water extracts exercise an increase in breadth of guard cells. However, influence of 1 percent ether extract is more pronounced than 2 percent water extract.

Statistical analysis of data shows that observed effects of both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

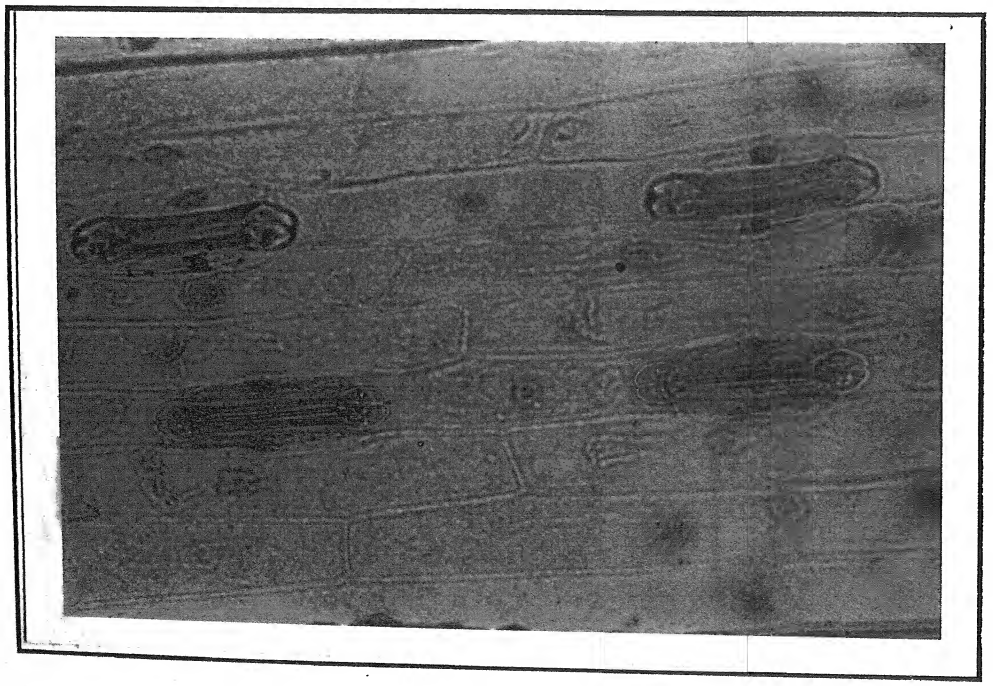
INFLUENCE OF 12 HRS PRE-SOAKING SEED TREATMENT ON EPIDERMAL CELLS :

NUMBER OF EPIDERMAL CELLS PER MICROSCOPIC FIELD :

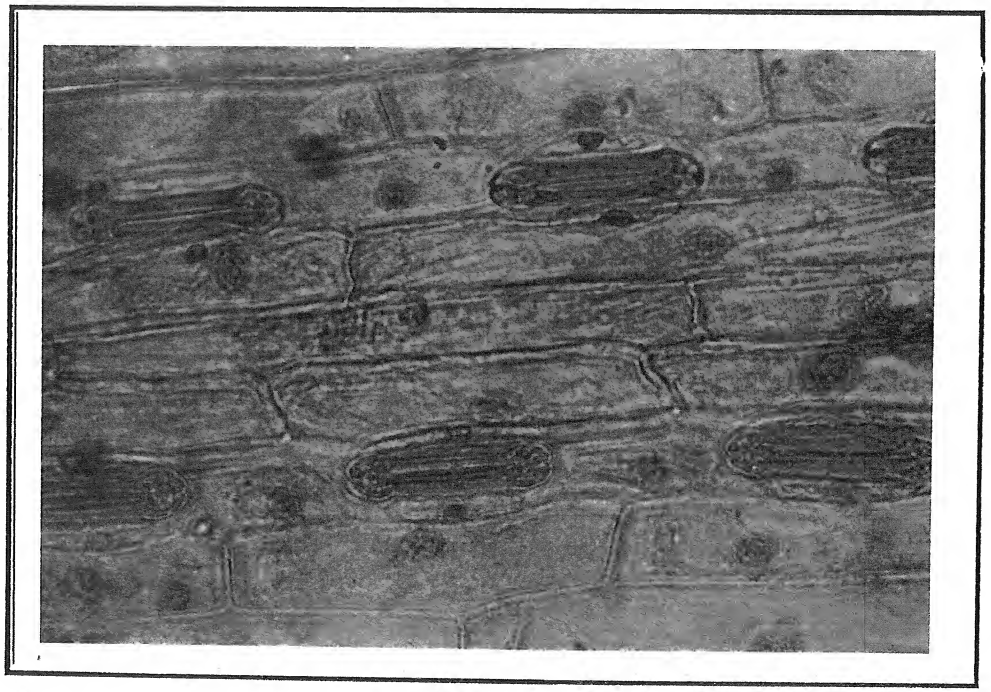
Observations entered in Table-19 and Photo-19 show that there is an increase in number of epidermal cells per microscopic field under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more stimulatory in increasing number of epidermal cells as compared to water extract.

Statistical analysis of data shows that observed effects of both 1 percent ether and water extracts are significant at 5 percent error probability.

PHOTO - 19 : EFFECT OF 12 HOURS TREATMENT WITH ***Spirodella polyrhiza*** EXTRACTS ON LOWER EPIDERMAL STRUCTURE OF WHEAT LEAF



CONTROL



1 PERCENT ETHER - WATER EXTRACT

NUMBER OF STOMATA PER MICROSCOPIC FIELD :

Results entered in Table-19 and Photo-19 show that there is an increase in number of stomata per microscopic field under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more effective in increasing number of stomata as compared to water extract.

Results were statistically analysed following analysis of variance method and observed effects of both 1 percent ether and water extracts are significant at 5 percent error probability.

LENGTH OF EPIDERMAL CELL :

An examination of Table-19 and Photo-19 indicates that there is an increase in length of epidermal cells under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more stimulatory in increasing length of epidermal cell as compared to water extract.

Statistical analysis of data shows that observed effect of both 1 percent ether and water extracts are significant at 5 percent error probability.

BREADTH OF EPIDERMAL CELL :

A perusal of Table-19 and Photo-19 shows that there

is an increase in breadth of epidermal cells under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more effective in increasing breadth of epidermal cell as compared to water extract.

Results were statistically analysed and observed increases with both 1 percent ether and water extracts are significant at 5 percent error probability.

PERIMETER OF STOMATAL PORE :

Observations given in Table-19 and Photo-19 shows that there is an increase in perimeter of stomatal pore under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more stimulatory in increasing perimeter of stomatal pore as compared to water extract.

Statistical analysis of data shows that observed effects of both 1 percent ether and water extracts are significant at 5 percent error probability.

LENGTH OF GUARD CELLS :

Results entered in Table-19 and Photo-19 show that there is an increase in length of guard cells under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more effective as compared to water

extract.

Results were statistically analysed following analysis of variance method and observed effect of 1 percent ether extract is significant at 5 percent error probability.

BREADTH OF GUARD CELLS :

An examination of Table-19 and Photo-19 shows that there is an increase in breadth of guard cells under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more stimulatory than water extract.

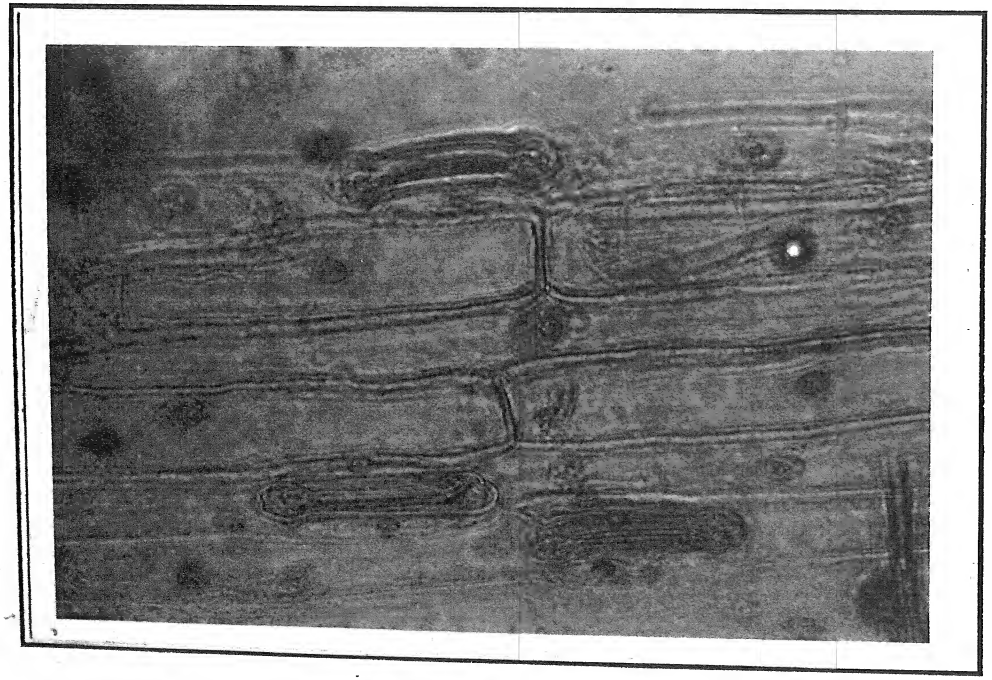
Statistical analysis of data shows that observed effects of both 1 percent ether and water extracts are significant at 5 percent error probability.

INFLUENCE OF 24 HRS PRE-SOAKING SEED TREATMENT ON EPIDERMAL CELLS :

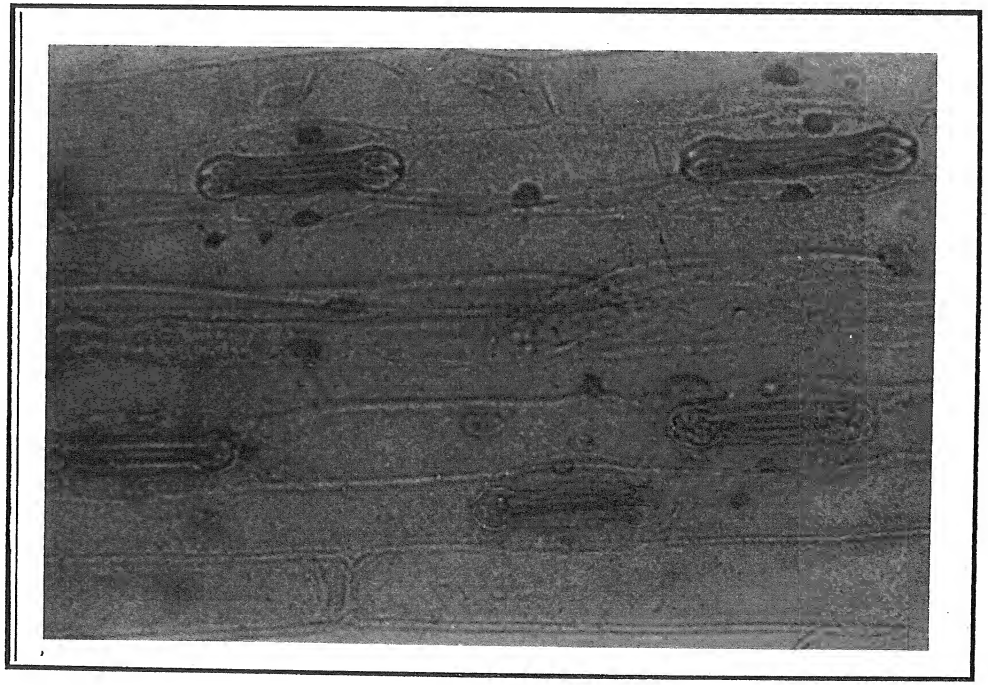
NUMBER OF EPIDERMAL CELLS PER MICROSCOPIC FIELD :

Observations entered in Table-19 and Photo-20 show that there is an increase in number of epidermal cells per microscopic field under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract marks more stimulatory effect on number of epidermal cells as

PHOTO - 20 : EFFECT OF 24 HOURS TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON LOWER EPIDERMAL STRUCTURE OF WHEAT LEAF



CONTROL



1 PERCENT ETHER - WATER EXTRACT

compared to water extract.

Statistical analysis of data shows that observed effects of both 1 percent ether and water extracts are significant at 5 percent error probability.

NUMBER OF STOMATA PER MICROSCOPIC FIELD :

Results entered in Table-19 and Photo-20 show that there is an increase in number of stomata per microscopic field under both 1 percent ether and water extracts. However, 1 percent ether extract is more effective in increasing number of stomata as compared to water extract.

Results were statistically analysed and observed effects of both 1 percent ether and water extracts are significant at 5 percent error probability.

LENGTH OF EPIDERMAL CELL :

An examination of Table-19 and Photo-20 shows that there is an increase in length of epidermal cells under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more stimulatory as compared to water extract.

Statistical analysis of data shows that observed increases with both 1 percent ether and water extracts are significant

at 5 percent error probability.

BREADTH OF EPIDERMAL CELL :

A perusal of Table-19 and Photo-20 shows that there is an increase in breadth of epidermal cells under both 1 percent ether and water extracts. However, 1 percent ether extract is more effective towards imparting increase in breadth of epidermal cells as compared to water extract.

Results were statistically analysed following analysis of variance method and observed increases with both 1 percent ether and 2 percent water extracts are significant at 5 percent error probability.

PERIMETER OF STOMATAL PORE :

Observations given in Table-19 and Photo-20 show that there is an increase in perimeter of stomatal pore under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more stimulatory than water extract.

Statistical analysis of data shows that observed effects of both 1 percent ether and water extracts are insignificant at 5 percent error probability.

TABLE - 19 : RESPONSE OF LOWER LEAF EPIDERMIS OF WHEAT TO PRE-SOAKING SEED TREATMENT WITH ***Spirodella polyrhiza*** EXTRACTS

SOAKING PERIOD	NO. OF EPIDERMAL CELLS PER MICROSCOPIC FIELD			NO. OF STOMATA PER MICROSCOPIC FIELD			LENGTH OF EPIDERMAL CELL IN μ			BREADTH OF EPIDERMAL CELL IN μ			PERIMETER OF STOMATAL PORE IN μ			LENGTH OF GUARD CELLS IN μ			BREADTH OF GUARD CELLS IN μ		
	C	1% EW	2% W	C	1% EW	2% W	C	1% EW	2%W	C	1%EW	2%W	C	1%EW	2%W	C	1% EW	2% W	C	1% EW	2% W
6 HRS	24.13	26.34	26.11	3.73	4.53	4.38	261.43	291.21	285.44	25.61	30.37	28.71	30.47	31.41	30.93	78.24	82.34	81.41	5.84	7.34	6.94
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1%W	C	1% EW	1%W	C	1%EW	1%W	C	1% EW	1% W	C	1% EW	1% W
12 HRS	25.71	28.45	27.17	3.83	5.65	4.94	282.41	318.46	311.54	32.47	35.13	34.48	30.96	35.71	33.41	79.41	85.68	81.74	6.12	7.97	7.35
	C	1% EW	1% W	C	1% EW	1% W	C	1% EW	1%W	C	1% EW	1%W	C	1%EW	1%W	C	1% EW	1% W	C	1% EW	1% W
24 HRS	22.14	24.43	23.35	2.36	4.24	4.11	250.42	281.41	275.47	25.40	29.43	27.25	29.91	31.22	30.80	78.17	80.34	79.41	5.63	6.89	6.76
	C.D. = 0.68 DIFFERENCE 6 HRS 1% EW-C = 2.21 2% EW-C = 1.98			C.D. = 0.82 DIFFERENCE 6 HRS 1% EW-C = 0.80 2% W-C = 0.65			C.D. = 4.01 DIFFERENCE 6 HRS 1% EW-C = 29.78 2% W-C = 24.01			C.D. = 1.37 DIFFERENCE 6 HRS 1% EW-C = 4.76 2% W-C = 3.10			C.D. - 2.39 DIFFERENCE 6 HRS 1% EW-C = 0.94 2% W-C = 0.46			C.D. = 2.64 DIFFERENCE 6 HRS 1% EW-C = 4.10 2% W-C = 3.17			C.D. = 0.36 DIFFERENCE 6 HRS 1% EW-C = 1.50 2% W-C = 1.10		
	DIFFERENCE 12 HRS 1% EW-C = 2.74 1% W-C = 1.46			DIFFERENCE 12 HRS 1% EW-C = 1.82 1% W-C = 1.11			DIFFERENCE 12 HRS 1% EW-C = 36.05 1% W-C = 29.13			DIFFERENCE 12 HRS 1% EW-C = 2.66 1% W-C = 2.01			DIFFERENCE 12 HRS 1% EW-C = 4.75 1% W-C = 2.45			DIFFERENCE 12 HRS 1% EW-C = 6.27 1% W-C = 2.33			DIFFERENCE 12 HRS 1% EW-C = 1.85 1% W-C = 1.23		
	DIFFERENCE 24 HRS 1% EW-C = 2.29 1% W-C = 1.21			DIFFERENCE 24 HRS 1% EW-C = 1.88 1% W-C = 1.75			DIFFERENCE 24 HRS 1% EW-C = 30.99 1% W-C = 25.05			DIFFERENCE 24 HRS 1% EW-C = 4.03 1% W-C = 1.85			DIFFERENCE 24 HRS 1% EW-C = 1.31 1% W-C = 0.89			DIFFERENCE 24 HRS 1% EW-C = 2.17 1% W-C = 1.24			DIFFERENCE 24 HRS 1% EW-C = 1.26 1% W-C = 1.13		

ABBREVIATIONS USED : C - Control, EW - Ether-Water extract, W - Water extract, and C.D. - Critical Difference.

LENGTH OF GUARD CELLS :

Results entered in Table-19 and Photo-20 show that there is an increase in length of guard cells under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more effective in increasing length of guard cells as compared to water extract.

Results were statistically analysed following analysis of variance method and observed effects of both 1 percent ether and water extracts are significant at 5 percent error probability.

BREADTH OF GUARD CELLS :

An examination of Table-19 and Photo-20 shows that there is an increase in breadth of guard cells under treatments with both 1 percent ether and water extracts. However, 1 percent ether extract is more stimulatory towards increasing breadth of guard cells as compared to water extract.

Statistical analysis of data shows that observed effects of both 1 percent ether and water extracts are significant at 5 percent error probability.

DISCUSSION

DISCUSSION

Based on information scattered in the literature (Hillman, 1961) and preliminary observations made (Shukla, Pandey and Shukla, 1973; Shukla and Pandey, 1976; 1979) perimeters of study set up as described earlier for present investigation, bore fruits and revealed interesting results. They provided a new dimension of importance to lemnoids. Present investigation has brought to knowledge facts of both academic and applied significance. The utility of duckweeds in obtaining extracts to be employed in agriculture has further multiplied their importance. A correlative discussion of observations made during present investigation and facts recorded elsewhere in the literature would be provided a conceptual synthesis of subject matter.

The natural history and geographical distribution of duckweeds is suggestive of their global occurrence. About half of the total number of species of the family Lemnaceae are basically tropical or sub-tropical but rest of them are distinctly temperate. ***Spirodella polyrhiza, Lemna gibba, L. minor***

and ***L. perpusilla*** appear world wide in distribution. ***L. trisulca*** is confined to only cold climatic areas. Bulk of other ***Spirodellas, Wolffias*** and ***Wolffiellas*** are primarily Australasian, American, African or Asiatic tropical species (Hegelmaier, 1868). There are also reports of other lemnoid species from South America (Koch, 1932) and Australasian species from Missouri (Saeger, 1934). The known cosmopolitan lemnoids are conspicuously absent in certain localities. The aforesaid distribution is suggestive of the fact that further investigations might show either influx of lemnoids in certain localities as a result of their migration from elsewhere or their disappearance. Survey reports on estimated trends of duckweed infestations are also suggestive of their increase, decrease or constant growth in India (Varshney and Singh, 1973). Such observations have also remained tangible during present investigations and out of various cosmopolitan lemnoids referred to earlier, ***Lemna paucicostata, Spirodella polyrhiza*** and ***Wolffia arrhiza*** only could be recorded from habitats of Banda. This emphasises that perhaps dynamic features of habitats are closely linked with duckweed infestations.

General topics on lemnoid growth, distribution and details of nature of its habitats have met a cursory treatment in the literature (Guppy, 1894; Hicks, 1937; Rao, 1953;

Luther, 1951). The topic has been dealt in some detail by Landolt (1957), Arber (1920), and Shukla and Pandey (1979). The broader concepts are based on information on lemnoids like ***Lemna minor, L. valdiviana, L. trisulca, L. gibba, L. perpusilla, Wolffia punclata*** and ***Wolffiella lingulata.***

There are also casual reports about ***S. polyrhiza's*** response to temperature. As referred to earlier, growth of lemnoids in Banda has been obtained in slightly moving or stagnant waters of small ponds, ditches, drainage channels or sewer outlets rich in organic matter or they may continue to grow out of water on wet mud (McCley, 1974). The range of pH of water between 6.5 to 10.5, a varied sunlight to dense shade and temperature of 20 to 30°C supports duckweeds in Banda. Habitats and ecological conditions prevailing in Banda supporting duckweed growth fit in general within broad ambit of variance of environmental perimeters prevalent in lemnoid infested areas elsewhere but it is interesting to note that out of 20-30 lemnoid species (Hillman, 1961a) only three of them ***S. polyrhiza, L. paucicostata*** and ***W. arrhiza*** could be recorded from Banda. Notably it becomes apparent that light intensities, temperature range and nutritional backdrop of aquatic environment may only be conducive to growth of hitherto, referred species or the area still awaits invasion and

migration of other species from other localities, elsewhere.

During present study three lemnoid species have exhibited profuse turion formation and cloning in nature. The principal mode of reproduction happened to be cloning but ***L. paucicostata*** showed rare occurrence of both flowering and fruiting. However, other two lemnoids (***S. polyrhiza*** and ***W. arrhiza***) showed total absence of flowering. A perusal of literature shows that certain species. particularly ***L. gibba*** and ***L. perpusilla*** are frequently found to flower (Landolt, 1957). These two species have been unequivocally used as experimental material to study ***in vitro*** induction of flowering (Kandeler, 1955; Hillman, 1958). Other investigators have also induced flowering in ***L. perpusilla, Wolffia microscopica, W. papulifera*** and ***Wolfiella*** sp. (Mason, 1938; Maheshwari and Chauhan, 1963; Maheshwari and Venkataraman, 1966; Maheshwari and Seth, 1966; Maheshwari and Gupta, 1967; Gupta and Maheshwari, 1970a; 1970b etc.).

Flowering in other species notably ***S. polyrhiza*** and ***W. arrhiza*** is rare. Absence of flowering in ***W. arrhiza*** may well, therefore, be anticipated as observed during present investigation. Observations on absence of flowering in ***W. arrhiza*** are in conformity with earlier report of Bhambie

(1966.).

Aquatic environments supporting growth of lemnoids are beset with typical conditions due to interrelated interaction of duckweed infestation and environment. Luxurient growth of lemnoids virtually modified environment. Low oxygen content interlinked with high organic constituent, especially, organic nitrogen stimulate conditions ideal for growth of algae particularly Cyanophyceae in association with lemnoids (Stephanova, 1928; Rao; 1953; Shukla and Pandey, 1979).

Various investigators have used several media for culture of lemnoids. Among common media used M-sucrose medium (Oota, 1966; 1969; Pieterse, Bhalla and Sabharwal, 1970a); Hutner's medium (Pieterse, Bhalla and Sabharwal, 1970b); medium containing sucrose, casein hydrolysate, tryptophan and kinetin (Rombach, 1971); Hoagland's modified medium (Gorham, 1950); and Pirson and Siedel's medium may be cited. The best medium reported for maintaining vigorous growth over long periods of time in Hutner's medium. The question of auximone requirements and necessity of essential organic growth factors occupied frequent references in the literature (Bottomley, 1920a; 1920b; Mockeridge, 1924). These early works suggested that perhaps extracts of peats, leaf

mold, soil or manure are needed for growth and multiplication of lemnoids but later studies conclusively suggested that organic materials were not necessarily required (Ashby, 1929; Clark and Roller, 1924; 1931; Saeger, 1925; 1930; Wolfe, 1926). It was also demonstrated that ***Lemna*** grown in aseptic inorganic medium even formed larger amounts of vitamins A, B and C (Clark, Thomas and Frahm, 1938).

Despite these facts bulk of media used elsewhere contained organic compounds or metal chelators like EDTA. Reports that purely inorganic media sufficiently meet nutritional requirements led to study effects of certain pure inorganic media on growth of duckweeds during present investigations.

Major micro-elemental requirements of lemnoids constitute iron, manganese, molybdenum, boron, zinc, copper and gallium though necessity of the last three is not well established. Minute quantities of chloride also appear to be needed for growth of lemnoids (Hillman, 1961a).

Based on these facts the medium selected to undertake detailed experimental work contained K-2mg., Ca-4mg., Mg-2mg., P-2mg., N-6mg., Fe-5.6 ppm. Mn-O.23 ppm, Cu-O.032ppm, Zn-O.032ppm, Mo-O.025 ppm, B-0.185 ppm, Co-0.003 ppm and Ni-0.003 ppm (Strength per litre). This

medium exhibited marked improved growth and multiplication of ***S. polyrhiza.*** Known symptoms of deficiencies of macro and micro-nutrients described elsewhere (White, 1936; 1938; 1939' White and Templeman, 1937; Steinberg, 1946; Allison, Love, Pinck and Gaddy, 1948; Pirson and Gollner, 1953b; Bierhuizen, 1954; Martin, 1955; Reid and Bieleski, 1970) could not be observed during usage of hitherto, referred inorganic medium. This has further thrown light on auximone requirements of plants and substantiated the findings of Wolfe (1926), Ashby (1929) and Clark (1932) that organic substances are not required for prolonged growth of lemnoids (***L. paucicostata, S. polyrhiza*** and ***W. arrhiza***). The fact is of considerable significance for developing ***in vitro*** cultural technique to grow lemnoids under room temperature in tropical countries where addition of organic substances like sugars, coconut milk etc. is likely to set in fermentation of medium thereby obstructing aseptic growth of lemnoids.

Existence of growth-promoting substances in various plants has been known and their extraction for utilization in agriculture has also been emphasized in the literature. In addition to fungi and bacteria a number of higher plants have been reported to contain gibberellins (Katznelson, Sirosis and Cole, 1962' Brian, Hemming and Lowe, 1964; Maheshwari

and Bhatia, 1966; Jones and Lang, 1968; Pronano and Greene, 1968; Hayashi, Natto, Buckovac and Sell, 1968; Iwahori, Weaver and Pool, 1968). Gibberellins have been reported from some marine algae (Mowat, 1963; 1964; 1965; Jennings and McComb, 1967). Likewise, gibberellin-like substances have been reported in extracts of ***Phormidium foveolarum*** (Gupta and Shukla,1967; Gupta and Agarwal, 1973) and developing watermelon seeds (Bhalla, 1971). Growth promoting substances have also reported in root extracts of water hyacinth (Sircar and Kundu, 1960). There is evidence of endogenous gibberellins in floating plants and turions of ***Wolffiella floribanda*** (Pieterse, Bhalla and Sabharwal, 1971).

Exhaustive literature on utilization of algal extracts of ***Phormidium foveolarum*** in agriculture of rice (Gupta and Shukla, 1964; 1967; 1969; Shukla and Gupta, 1967; Shukla, 1968; 1975a); wheat (Kushwaha and Gupta, 1970a; 1970b; Shukla, 1975b), ***Vigna catzang*** (Gupta and Gupta, 1970; 1972; 1973) and ***Phaseolus aureus*** (Gupta and Gupta, 1972) is available. Shukla (1983) emphasized utilization of algal extracts to boost rice growth and productivity. Likewise, stimulation in vegetative growth and yield of rice following treatments with water hyacinth extracts has also been reported

(Sircar, 1963). Influence of ***L. paucicostata*** manure and spraying with its extracts on ***Hordeum vulgare*** was explored by Pandey (1979) and the study revealed significant effects on fresh and dry matter production, yield, ascorbic acid, catalase, chlorophyll and epidermal structure of plants.

Observations on juvenile seedling growth of wheat plants show that out of various concentrations (1, 2 and 5 percent) of extracts tried, 1 percent extract exhibits all-round maximum beneficial growth. Length of primary root, number of secondary roots and length of plumule exhibit marked increase with 1 percent extracts (except 6 hrs soaking with water extract where 2 percent extract is more effective). Improved seedling growth is proven with prospects of better crop.

There is uniform alround, maximum effectiveness of extracts in concentrations of 1 percent ether and 2 percent water in 6 hrs, 1 percent ether and 1 percent water in 12 hrs and 1 percent ether and 1 percent water extract in 24 hrs of ***S. polyrhiza***. Evidently, ether extracts of ***S. polyrhiza*** are more effective than water extracts.

Increases under 6 hrs treatments in length of primary root, number of secondary roots and length of plumule

increased 23.76, 55.76 and 85.74 percent with 1 percent ether extract respectively. However, increases in length of primary root, number of secondary roots and length of plumule were found to be 34.61, 64.09 and 89.67 percent with 2 percent water extract respectively during present investigation on expiry of experiments after 96 hrs. Increase under 12 hrs treatments in length of primary root, number of secondary roots and length of plumule increased 29.17, 40.93 and 75.12 percent with 1 percent ether extract respectively. Increases in length of primary root, number of secondary roots and length of plumule were found to be 26.93, 55.48 and 67.35 percent with 1 percent water extract respectively during present investigation on expiry of experiments after 96 hrs. Increase under 24 hrs treatments in length of primary root, number of secondary roots and length of plumule increased 46.93, 42.95 and 91.90 percent with 1 percent ether extract respectively, but increases in length of primary root, number of secondary roots and length of plumule were found to be 39.79, 60.64 and 96.94 percent with 1 percent water extract respectively.

Observations emphasize that in general effects of 12 hrs treatment with both ether and water extracts is better as compared to 6 and 24 hrs treatments. Stimulatory effect of

treatments gradually increases from 6 to 12 hrs treatments and declines with longer pre-soaking seed treatment period form 12 to 24 hrs.

Influence of ***S. polyrhiza*** extracts on mature wheat plant growth and yield have shown promising results. One percent ether extract under 6, 12 and 24 hrs pre-soaking exercised increased in height of plants, number of tillers, number of leaves, length of leaves and breadth of leaves. Treated plants were more livelier and intensely green. Increased tillering is of paramount importance as it is interlinked with production of ears and consequently the yield.

Influence of 6 hrs treatments with 1 percent ether extracts of ***S. polyrhiza*** showed increases of 8.40, 39.65, 38.37, 18.92 and 27.01 percent over control on height of plants, number of tillers, number of leaves, length of leaves and breadth of leaves respectively. An increase of 6.30, 20.27, 21.22, 8.74 and 10.29 percent under effect of treatments with 2 percent water extract was observed on height of plants, number of tillers, number of leaves, length of leaves and breadth of leaves respectively. Influence of 12 hrs treatments with 1 percent ether extract of ***S. polyrhiza*** showed increases of 8.62, 48.65, 50.47, 26.32 and 27.56 percent over control on height of plants, number of tillers, number of leaves,

length of leaves and breadth of leaves respectively. An increase of 5.90, 28.07, 18.14, 8.79 and 13.14 percent under effect of treatments with 1 percent water extract was observed on height of plants, number of tillers, number of leaves, length of leaves and breadth of leaves respectively. Likewise 24 hrs treatments with 1 percent ether extract of ***S. polyrhiza*** showed increases of 6.62, 32.44, 36.67, 9.81 and 28.48 percent over control on height of plants, number of tillers, number of leaves, length of leaves and breadth of leaves respectively. An increase of 5.05, 20.69, 19.22, 7.22 and 4.30 percent under effect of treatments with 1 percent water extract was observed on height of plants, number of tillers, number of leaves, length of leaves and breadth of leaves respectively.

Results on increase with 6, 12 and 24 hrs treatments show that in case of ether extracts there is a gradual increase in effect with increase in pre-soaking period of seeds with 6 and 12 hrs and declines with 24 hrs. However, in case of water extract height of plants. number of tillers, number of leaves, length of leaves, and breadth of leaves in 12 hrs treatment was found to be multiplied to the maximum extent.

Data on crop productivity shows that dry weight of straw per plant, dry weight of ears per plant, dry weight of single ear, dry weight of 1000 seeds, percentage ear emergence per

day and time required for ear emergence is higher in plants treated with 1 percent ether extract in 6, 12 and 24 hrs pre-soaking.

Percentage increases with 1 percent ether extract and 6 hrs. treatment in dry weight of straw per plant, dry weight of ears per plant, dry weight of single ear, dry weight of 1000 seeds, percentage ear emergence per day and time required for ear emergence was found to be 146.54, 120.21, 102.21, 25.78, 83.66 and 14.63 percent respectively. However, 2 percent water extract under 6 hrs treatment increased 62.96, 68.88, 61.88, 16.47, 54.88 and 4.88 percent in dry weight of straw per plant, dry weight of ears per plant, dry weight of single ear, dry weight of 1000 seeds, percentage ear emergence per day and time required for ear emergence respectively. Percentage increases with 1 percent ether extract and 12 hrs treatment in dry weight of straw per plant, dry weight of ears per plant, dry weight of single ear, dry weight of 1000 seeds, percentage ear emergence per day and time required for ear emergence was found to be 195.58, 145.53, 71.55, 22.94, 32.40 and 13.92 percent respectively. However, 1 percent water extract under 12 hrs treatment increased 59.61, 120.94, 47.84, 16.78, 16.94 and 3.80 percent in dry weight of straw per plant, dry weight of ears per plant, dry

weight of single ear, dry weight of 1000 seeds, percentage ear emergence per day and time required for ear emergence respectively. Percentage increases with 1 percent ether extract and 24 hrs treatment in dry weight of straw per plant, dry weight of ears per plant, dry weight of single ear, dry weight of 1000 seeds, percentage ear emergence per day and time required for ear emergence was found to be 143.17, 83.76, 74.25, 25.86, 73.40 and 13.95 percent respectively. One percent water extract under 24 hrs treatment increased 65.30, 50.02, 52.12, 12.20, 48.85 and 5.81 percent in dry weight of straw per plant, dry weight of ears per plant, dry weight of single ear, dry weight of 1000 seeds, percentage ear emergence per day and time required for ear emergence respectively.

Results obtained emphasized that increase in weight of single ear is proportional to weight of seeds produced. It may be suggested that although seeds and ears produced in treated plants are heavier, the final yield depends on the number of ears produced per plant to a very large extent and appears to be controlled and coordinated partly by number of tillers developed per plant.

Results indicate that vegetative dry matter production and yields in ether and water extracts were stimulated with

increase in pre-soaking period of seeds with ***S. polyrhiza*** extracts and maximum yields were observed with 12 hrs treatments. The data is suggestive of the fact that weight of single ear and 1000 seeds are not crucial for yields but number of ears per plant produced controls the final outcome of yields.

Judging critically while response of various treatments on multiple parameters of seedling (length of primary root, number of secondary roots and length of plumule) and mature vegetative growth (height of plants, number of tillers, number of leaves, length of leaves and breadth of leaves) may show variance it is finally vegetative dry matter production and yield which matters as an index to gauge effectiveness of treatments. On the basis of this it may be said that the vegetative growth and yield is multiplied to the maximum extent with 1 percent ether extract under 12 hrs pre-soking seed treatment. Application of 1 percent ether extract of ***S. polyrhiza*** and 12 hrs pre-soaking seed treatment is therefore, recommended for adoption by agriculturists.

When multiple effects of ***S. polyrhiza*** extracts containing growth promoting substances on wheat plants are examined it becomes evident that concentration, kind of extract, nature of treatment and environmental conditions all play important

role in the final outcome of treatment.

Observations emphasize that 1 percent ether extract under pre-soaking seed treatments of 12 hrs appears to be needed to stimulate seedling growth, vegetative growth of mature plants and grain yield. Results emphasize that for sustained effects of treatments longer pre-soaking seed treatments yield better results. Sufficiency of 12 hrs treatments in case of ether extracts emphasizes better extraction of growth substances with ether than water. Extraction of plant material for pre-soaking seed treatment was made in water and ether extract suspended in ether. It was observed that stimulatory effect of ***S. polyrhiza*** extracts depends upon nature of extract and soaking period. Conclusively, effect of 12 hrs pre-soaking seed treatment with 1 percent ether extract suspended in water of ***S. polyrhiza*** exercised maximum stimulation in growth, development and yield of wheat plants.

The mineral matter in flour is not quantitatively large but has considerable impact on quality and behaviour of flour. Percentage of mineral matter is indicator of grade and quality of the flour. It is well known that elemental composition in wheat is dependent on nature of soil (Beeson, 1941; Booth, Carter, Jones and Moran, 1941). A good deal of variance in mineral matter of Indian wheats has been observed. Availability

of larger quantities of nitrogen and phosphatic fertilizers to wheat resulted in higher protein and phosphorus content in wheat grains (Bains, 1949). There appears migration of nitrogen, phosphorus and potash during different stages of crop.

In the light of significance of mineral constituents of wheat grains changes in nitrogen, phosphorus and potash are of pivotal importance in controlling quality of wheat flour. The nitrogen and protein contents go hand in hand.

The percentage of protein under influence of 1 percent ether extract 6 hrs treatment in root, stem, leaf and wheat grains increased 8.96, 24.89, 55.69 and 7.44 percent respectively. However, an increase of 3.30, 8.44, 45.15 and 4.61 percent were observed with 2 percent water extract in case of root, stem, leaf and grains respectively. The percentage of protein under influence of 1 percent ether extract 12 hrs. treatment in root, stem, leaf and wheat grains increased 17.78, 31.65, 60.94 and 10.45 percent respectively. But an increase of 33.33, 24.05, 51.17 and 8.18 percent were observed with 1 percent water extract in case of root, stem, leaf and grain respectively. The percentage of protein under influence of 1 percent ether extract 24 hrs. treatment in root, stem, leaf and grains increased 9.22, 20.75, 54.11 and 7.51

percent respectively. An increase of 2.91, 11,79, 32.47 3.76 percent were observed with 1 percent water extract in case of root, stem, leaf and grains respectively.

The percentage of nitrogen under influence of 1 percent ether extract 6 hrs treatment in root, stem, leaf and wheat grains increased 8.82, 25.00, 55.26 and 7.44 percent respectively. However, an increase of 2.94, 8.33, 44.74 and 4.65 percent were observed with 2 percent water extract in case of root, stem, leaf and grains respectively. The percentage of nitrogen under influence of 1 percent ether extract 12 hrs treatment in root, stem, leaf and wheat grains increased 44.44, 31.58, 60.98 and 11.87 percent respectively.However, an increase of 33.33, 23.68, 51.22 and 8.22 percent was observed with 1 percent water extract in case of root, stem, leaf and grains respectively. The percentage of nitrogen under influence of 1 percent ether extract 24 hrs treatment in root, stem, leaf and grains increased 9.09, 20.59, 54.05, 7.51 percent respectively. However, an increase of 3.03, 1.18, 32.43, 3.76 percent were observed with 1 percent water extract in case of root, stem, leaf and grains respectively.

The percentage of phosphorus under influence of 1 percent ether extract 6 hrs treatment in root, stem, leaf and wheat grains increased 5.56, 1.55, 3.07 and 18.39 percent

respectively. Increase of 3.57, 0.78, 0.77 and 4.67 percent was observed with 2 percent water extract in case of root, stem, leaf and grains respectively. The percentage of phosphorus under influence of 1 percent ether extract 12 hrs treatment in root, stem, leaf and wheat grains increased 5.40, 5.28, 4.51 and 11.10 percent respectively but increases of 4.25, 3.39, 3.01 and 9.03 percent were observed with 1 percent water extract in case of root, stem, leaf and grains respectively. The percentage of phosphorus under influence of 1 percent ether extract 24 hrs. treatment in root, stem, leaf and wheat grains increased 5.18, 1.57, 2.32 and 7.65 percent respectively.However, an increase of 2.79, 0.78, 1.16 and 5.05 percent were observed with 1 percent water extract in case of root, stem, leaf and grains respectively.

The percentage of potash under influence of 1 percent ether extract 6 hrs treatment in root, stem, leaf and wheat grains increased 7.69, 5.59, 6.33 and 15.25 percent respectively. Observed increase of 3.20, 0.62, 3.16 and 6.78 percent with 2 percent water extract in case of root, stem, leaf and grains respectively was recorded. The percentage of potash under influence of 1 percent ether extract 12 hrs treatment in root, stem, leaf and wheat grains multiplied 6.88, 5.29, 9.04 and 13.04 percent respectively. However, an increase of 5.63,

2.94, 6.02 and 7.25 percent with 1 percent water extract of ***S. polyrhiza*** plants in case of root, stem, leaf and grains respectively was observed.

The percentage of potash under influence of 1 percent ether extract 24 hrs treatment in root, stem, leaf and wheat grains increased 7.84, 3.14, 5.10 and 12.07 percent respectively and an increase of 3.27, 1.26, 1.91 and 1.57 percent with 1 percent water extract in case of root, stem, leaf and grains respectively was recorded.

A perusal of protein increase may be viewed in the light of the fact that stem and leaf form straw used for feeding cattle while grain is meant for human consumption. Observed increases in protein contents of both straw and grains are therefore of significance.

During present investigation ***S.polyrhiza*** extracts have exercised increase in protein, nitrogen, phosphorus and potash constituents of the grain which are of considerable significance towards edible value and roughage quality of wheat. Observed increases appear to be at the expense of other constituents of lesser commercial significance.

Results of present investigation show that there is a marked influence of ***S. polyrhiza*** extracts on growth,

development and yield of wheat plants. The results are in agreement with Sircar (1963) who has similarly reported stimulated growth of rice following treatments with root extract of water hyacinth; barley with ***Lemna paucicostata*** extracts (Pandey, 1979)' and wheat with ***Pistia stratiotes*** extracts (Maurya, 1983). Results are suggestive of the fact that application of ***S. polyrhiza*** extracts not only results in more protein rich wheat productivity but also induces larger mineral constituents thereby improving the quality of flour. It would be of interest to compare straw and grain yield of wheats under applications of ***Pistia stratiotes*** extracts described elsewhere (Maurya, 1983) with relative promotion in productivity implemented by ***S. polyrhiza*** extracts during present investigation. While ***P. stratiotes*** extracts stimulated 85.5 percent in straw and 38.0 percent in grain yield. ***S. polyrhiza*** extracts provided a much higher boost to productivity, to the extent of 195.54 and 145.53 percent in straw and grain yield respectively. Conclusively, effectiveness and utility of ***S. polyrhiza*** is higher than ***P. stratiotes*** extracts for adoption in practical agriculture of wheat.

The physiological peculiarities of plants in general and rice in particular (Sircar, 1958) are known to possess different auxin levels at various sites which appears to control growth

and developmental pattern in various parts of the plants. A high IAA content of endosperm regulates germination and seedling growth in rice (Sircar and Das, 1954). Sircar and Dutta Ray (1962) realised the significance of IAA in nitrogen metabolism of germinating seeds. Internal IAA level has also been presumed to be linked with subsequent plant growth and tillering (Sircar and Parija, 1949; Sircar and Das, 1954). Increase in IAA level of stamens and carpels till anthesis appears to result in reproductive growth (Sircar and Chakravarty, 1957). Thus, various physiological processes of rice are regulated by IAA in various organs. It has been suggested that auxin level in rice occurs in two parts. A bulk of auxin remains in inactive form in vacuoles and active auxin part below suboptimal concentration is found at the sites of growth to bring about stimulation. Exogenous supplies of other growth regulators, sets in a competition between native IAA and exogenous growth regulators which displaces native auxin from its natural site of action leading to higher concentration of free auxin to exercise stimulated growth (Sircar, 1958).

It may suggested that a similar auxin level controlled mechanism as referred to earlier in case of rice may be operative in wheat under exogenous supply of growth substances present in ***S. polyrhiza*** extracts. The application of ***S.***

polyrhiza extracts containing growth substances suggest complex relationship between internal auxin level and external application of growth substances present in extracts. Changed growth, yield, metabolism and morpho-anatomical peculiarities are results of their action intermesh yielding fine fabric of stimulated growth and yield.

A perusal of results on the effect of ***S. polyrhiza*** extracts on diameter of xylem and phloem tissues and size of tracheids shows a marked alteration. The xylem-phloem and ground tissue ratio is concomittantly effected. The increase in xylem-phloem tissue appears to be at the expense of cortex and ground tissue.

A comparison of results of 6, 12 and 24 hrs pre-soaking seed treatment on anatomy shows significant changes. Twelve hours treatment is effective to the maximum extent. Influence of ether extract in 6, 12 and 24 hrs are more pronounced.

Results on anatomy of root show that 6, 12 and 24 hrs. treatments with ether extract of ***S. polyrhiza*** uniformly stimulate formation of xylem and phloem tissue coupled with increase in the size of tracheids.

There is a uniform alround maximum effectiveness of 1 percent ether and 2 percent water (6 hrs), 1 percent ether

and 1 percent water (12 and 24 hrs) extracts of ***S. polyrhiza*** examined. Evidently, ether extracts of ***S. polyrhiza*** are more effective than water extracts. Increase in diameter of root, diameter of stele, diameter of vascular bundles, diameter of metaxylem, number of protoxylem per microscopic field and number of root hair per microscopic field to the extent of 8.81, 17.65, 11.19, 11.15, 18.24 and 5.66; 13.57, 15.33, 10.44, 13.39, 13.46 and 13.05; 11.07, 14.26, 10.38, 16.47, 19.90 and 6.98 percent over control in 6, 12 and 24 hrs treatments respectively in roots with ether extracts have been recorded. Diameter of root, diameter of stele, diameter of vascular bundle, diameter of metaxylem, number of protoxylem per microscopic field, number of root hair per microscopic field increased 2.93, 4.72, 8.06, 5.56, 3.62 and 3.74; 7.04, 9.13, 7.10, 2.47, 3.48 and 6.05; 7.36, 5.20, 6.62, 8.39, 9.20 and 2.37 percent with water extract under 6, 12 and 24 hrs treatments respectively.

Anatomy of stem is also markedly influenced by ***S. polyrhiza*** extracts. Twelve hrs treatment with ether extract exercises maximum increase in diameter of xylem tissue, diameter of phloem tissue, diameter of stem, diameter of metaxylem, diameter of protoxylem and number of vascular bundles in stem.

Diameter of xylem tissue, diameter of phloem tissue, diameter of stem, diameter of metaxylem, diameter of protoxylem and number of vascular bundles increased 23.02, 19.88, 13.86, 27.97, 7.66 and 39.90; 24.00, 23.49, 11.55, 16.80, 8.65 and 27.87; 26.14, 31.93, 39.35, 33.52, 17.36 and 40.71 percent with ether extract under 6, 12 and 24 hrs treatments respectively in stem. Diameter of xylem tissue, diameter of phloem tissue, diameter of stem, diameter of metaxylem, diameter of protoxylem and number of vascular bundles increased 11.35, 5.50, 7.80, 22.38, 3.70 and 22.72; 8.97, 7.90, 10.99, 11.81, 2.68 and 18.06; 16.48, 16.32, 34.81, 18.29 14.11 and 19.56 percent with water extract under 6, 12 and 24 hrs treatments respectively.

The number of tracheary elements found in the tension wood induced by DNP in some seedlings are either equivalent or in others slightly reduced, relative to the number of tracheary elements present in xylem formed before treatment. In the ***Acer rubrum*** system (Morey, 1968a; 1968b) it is probable that the relative frequency at which tracheary elements are initiated from the fusiform initials related to the level of auxin in the cambial initiation zone. This implies that the level of auxin in the system below the DNP treatment site where tracheary elements are initiated from the dividing

initials or adjacent cambial derivatives is largely uneffected by treatment with DNP. It seems inconsistent, on the other hand that the capacity of DNP to induce the formation of tension wood in the same region of the stem is explained in terms of developmental response to auxin deficiency. However, the cambial derivatives undergoing secondary wall development, namely the xylem elements in the wall thickening phase of development are segregated from the cambial initials by more or less arbitrary zone of cells in which the walls are expanding by surface growth (Morey and Cronshaw, 1966). In this regard DNP may be more effective in lowering the auxin level in the centripetal zone of the stem than in the peripheral peristematic region.

This synoptical background about development of tracheids is clearly indicative of the fact that development of xylem is linked with auxin level in both root and stem. Auxin deficiency stimulates development of xylem. Exogenous supplies of certain growth substances which blocked polar transport of auxins create deficiency of auxin in areas just above the region of blockade (Cronshaw and Morey, 1965). During present investigation exogenous supply of growth substances in extracts of ***S. polyrhiza*** extracts provided through pre-soaking seed treatment appear to set in some kind of

competion with the endogenous auxin levels and displace auxin through ploar transport to the extremities of root and stem to initiate their apical growth, and in the process create conditions of auxin deficiency in the older regions of two organs, thereby stimulating development of xylem in the root and shoot. This may explain the increased formation of xylem, phloem and diameter of tracheids observed during present investigation.

Number of epidermal cells per microscopic field, number of stomata per microscopic field, length of epidermal cell, breadth of epidermal cell, perimeter of stomatal pore, length of guard cells and breadth of guard cells increased 14.00, 60.73, 16.02, 15.18, 16.71, 10.90 and 42.40; 9.80, 46.52, 46.21, 19.50, 24.02, 11.01 and 25.59; 6.99, 75.58, 9.61, 12.08, 13.28, 11.59 and 40.58 percent with ether extract under 6, 12 and 24 hrs treatments respectively on upper epidermis of leaves.

Number of epidermal cells per microscopic field, number of stomata per microscopic field, length of epidermal cell, breadth of epidermal cell, perimeter of stomatal pore, length of guard cells and breadth of guard cells increased 4.75, 28.86, 5.34, 4.56, 10.05, 6.39 and 22.24; 4.78, 21.66, 31.53,

11.78, 12.49, 5.83 and 12.82; 3.54, 70.50, 7.13, 3.59, 3.90, 4.19 and 17.69 percent with water extract under 6, 12 and 24 hrs treatments respectively on upper epidermis of leaves.

Number of epidermal cells per microscopic field, number of stomata per microscopic field, length of epidermal cell, breadth of epidermal cell, perimeter of stomatal pore, length of guard cells and breadth of guard cells increased 9.16, 21.45, 11.39, 18.59, 3.09, 5.24 and 25.68; 10.66, 47.52, 12.77, 8.19, 15.35, 7.90 and 30.23; 10.34, 79.66, 12.38, 15.87, 4.38, 2.78 and 22.38 percent with ether extract under 6, 12 and 24 hrs treatment respectively on lower epidermis of leaves.

Number of epidermal cells per microscopic field, number of stomata per microscopic field, length of epidermal cell, breadth of epidermal cell, perimeter of stomatal pore, length of guard cells and breadth of guard cells increased 8.21, 17.43, 9.18, 12.10, 1.51, 4.05 and 18.84; 5.68, 22.98,. 10.31, 6.19, 7.91, 2.93 and 20.10; 5.47, 74.15, 10.00, 7.28, 2.98, 1.59, 20.07 percent with water extract under 6, 12 and 24 hrs treatments respectively on lower epidermis of leaves.

The stomata are principal portals through which gaseous exchanges take place between the intercellular spaces and surrounding atmosphere. The efficiency of stomatal apparatus

in controlling gaseous exchanges of the plants was extensively studied by Brown and Escombe (1900), who have pointed out that the rate of diffusion through small openings (like stomata) in a given period of time is proportional to the perimeter and not to the area of the pore. The greater the perimeter, the more rapid is the rate of diffusion. Earlier observations of Shukla (1967) revealed that application of 1 percent extract of ***Phormidium foveolarum*** reduces the size of stomata in treated rice plants but increases their number and perimeter. Consequently, it was suggested that there would be more rapid diffusion of carbon dioxide in the leaves of treated rice plants. Similar influence of algal extracts on stomatal and epidermal development of wheat leaves (Shukla, 1975b) and synthetic growth substances on maize leaves has been recorded earlier (Shukla and Shukla, 1975).

Thimann and Skoog (1940) and Thimann, Rander and Byer (1942) used a plant ("***Lemna minor***") later identified as ***S. oligorrhiza*** and used by Thimann and Edmondson (1949) for tests of auxin extraction methods. Extracts were assayed for auxins by the ***Avena*** curvature test but no extraction was possible with water, or alkaline autoclaving. Sargent (1957) used both long and short-term extractions with ether or water, followed by paper partition chromatography

and ***Avena*** coleoptile section tests to assay the growth-active components in ***L. minor.*** Four growth-promoting substances and one inhibitor were found, their proportions depended upon the extraction techniques used. The major promoter was tentatively identified as indolacetic acid on the basis of its Rf value in the solvent system used.

The crude fresh extract of ***S. polyrhiza*** plants applied to wheat crop appears to contain growth substances, interestingly containing such a mixture of substances that provides an ideal blending of growth-factors sufficiently endowed to give general boost to the crop expressed in terms of altering growth, development, morpho-anatomy, metabolism and yield of wheat crop.

Present findings emphasized the significance of ***S. polyrhiza*** infestation, and how best they could be grown under ***in vitro*** mass culture and utilized for obtaining extracts which possess tremendous capacity to boost not only juvenile seedling growth and development of wheat crop but also exercised stimulation in vegetative growth, development and yield. The stomatal and epidermal structures also acquired better adoptability for gaseous exchanges vital for photosynthetic activity. Treatments also altered quality of wheat to the advantage by enriching them with higher protein and mineral

constituents thereby improving the quality of flour. The morpho-anatomical features following such treatments were so altered that render plants better adopted for life and productivity. The treated plants were not only intensely green with larger tillering and profuse development of broader and longer leaves but their stems and roots possessed better conducting tissues. This may partially explain the beneficial effect of ***S. polyrhiza*** extracts on growth of wheat plants.

Large infestation of ***S. polyrhiza*** plants with its known noxious importance is also endowed with great potential to multiply yield and alter quality of wheat crop. The findings are of paramount academic and applied significance, and are proven with promising possibilities for utilization of ***S. polyrhiza*** extracts by growers of commercial crop of wheat for higher and better quality wheat production.

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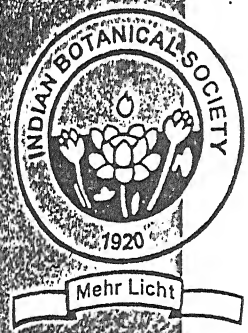

ABSTRACTS

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SECTION VIII

MORPHOGENESIS, PLANT TISSUE CULTURE AND BIOTECHNOLOGY

VIII-1 *IN VITRO* ANTHER CULTURE STUDIES IN NEEM (*AZADIRACHTA INDICA* A. JUSS). K. JANARDHANAN, Seed Technology Laboratory Botany Department Bharathiar University Coimbatore - 641 046 (T. N.).

The floral buds (2 mm long) from elite neem tree were collected. The dissected and excised anthers were surface sterilised with 0.1% (W/V) mercuric chloride for 10 min. followed by tween 20 at a concentration of 0.05% (V/V). They were thoroughly washed with sterile Millipore water. Anther explants were planted onto Nitsch & Nitsch (N&N) (1969) basal medium supplemented with 0.2 mg/1 BAP and different concentrations of NAA or IAA or 2,4 - D for callus induction. Profuse callusing from anthers occurred when anthers were cultured on N&N basal medium supplemented with 0.2 mg/1 BAP and 1.5 - 2.0 mg/1 NAA in 4 weeks after culture.

Shoot bud induction was achieved by subculturing neem calli on Murashige & Skoog's (MS) (1962) medium supplemented with different concentration of BAP, KN and NAA or by supplementing the basal medium with 0.2 mg/1 BAP + 0.1 mg/1 KN along with different concentrations of Ga_3. Induction of maximum number of shoots was recored on the aforesaid basal medium supplemented with 1.0 mg/1 BAP; 0.5- 0.75 mg/1 KN and 0.1 mg/1NAA. Similarly the aforesaid basal medium when supplemented with 0.2 mg/1 BAP, 0.1 mg/1KN and 1.0 - 1.5 mg/1 Ga_3 also registered the formation of maximum number of shoots 8 weeks after subculture. Root induction from the regenerated shoots was effected by subculturing the dissected shoot buds on the aforesaid basal medium supplemented with 1.0 - 2.0 mg/1 IAA in four weeks time. Thus entire neem plantlets were restored in a stepwise sequential in vitro micropropagation technology.

VIII 2 A PRELIMINARY SURVEY OF LEMNOIDS IN BANDA U. P. A. K. TRIPATHI AND A. K. AWASTHI, Department of Botany, Pt. J. N. P. G. College, Banda (U. P.)

A preliminary survey of lemnoids in Banda district has been made

during present investigation. Four genera spread over 4 species were collected during present investigation. Species of *Spirodella* followed by *Lemna* was dominant. *Lemna paucicostata, walffia arrhiza, Spirodella polyrhiza* and *Azolla pinnata* were recorded.

Biotechnological research involve converting discoveries in new biology into agricultural applications. While genetic research has led to production of high yielding varieties of crops, there has been a need for supplementing requirements to improve crop productivity. Balance supply of nutrition and hormonal control of growth in unison are unarrailable for strong agricultural economy.

Utilization of growth promoting substances present in these aquatic plant extracts are known to boost crop productivity. Present investigation has been made explore the possibilities of utilization of these duck-weeds to boost the productivity of different crops growing in Banda district as well as Bundelkhand region.

VIII-3 *IN VITRO* PROPAGATION OF *GYMNEMA SYLVESTRE* R.Br. THROUGH LONG TERM CALLUS CULTURE. SANTI SAHOO AND RITARANI DAS, P. G. Department of Botany, Utkal University.

In recent years the technique of tissue and organ culture has been effectively used in the mass multiplication of a number of plants of medicinal values. However, in a few cases the leaf material has been used as the source of tissue. *Gymnema sylvestre* R. Br. is a woody climber and is highly stomachic, stimulant, laxative and diuretic. The leaves have been used as a remedy for diabetes. The leaves of this plant contain gymnemic acid hentriacontane, pentatriacontane, resins, tartaric acid, formic acid, butyric acid, anthraquinone derivaties and insitol, this plant is currently considered to be a commercial source of gymnemic acid. Vegetative propagation of this plant is not so easily possible. Depending upon the importance of this plant, a large scale production of this plant is necessary. The present investigation was therefore, taken to develop an efficient tissue culture method for plantlet formation from leaf tissues of *G. sylvestre.*

In vitro clonal propagation of *G. sylvestre* an important medicinal plant has been achieved through callus culture. Callusing was achieved on RT medium which was found to be an excellent callusing medium for this

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including plant height number of branches, number of leaves, leaf areas were recorded at fortnightly intervals. Comparisons were also made with respect to dry matter increase RGR, NAR and leaf area increase on weekly basis. The plants of *C. verrucosa* were with consistent higher number of branches and plant height. The dry matter accumulation and leaf area increase also showed similar trend in both the species. However, in later stages these values showed enhancement in *C. grahmiania* corroborating the biennial nature of the plant. The NAR corresponded the RGR in both the species while the former showed typical upswinging in the later stages of growth. *Crotalana verrucosa* on the other hand displayed the decreasing trend of RGR and NAR with aging days. It flowered over 70 days. While the other species remained vegetative even after 84 days of sowing.

VII-11 **STUDIES ON THE EFFECT OF *SPIRODELLA POLYRHIZA* EXTRACTS ON POTTASH CONTENT OF WHEAT**, A.K. TRIPATHI & A.K. AWASTHI, Department of Botany, Pt. Jawahar Lal Nehru Post Graduate College, Banda-210 001 (U.P.).

Biotechnological research involve converting discoveries in new biology into agricultural applications. While genetic research has led to production of high yielding varieties of crops, there has been a need for supplementing requirements to improve crop productivity. Balance supply of nutrition and hormonal control of growth in unison are unarrailable for strong agricultural economy.

Influence of different concentrations (2 and 1 percent) of water and ether extract suspended in water on pottash content of wheat has been studied by pre-soaking seed treatment. Effect of *Spirodella polyrhiza* extracts on pottash content of wheat have shown promising results. Twelve hours treatment with 1 percent eather-water extract exercises maximum increase in pottash content of wheat. Observed increases in pottash content of grain are of considerable significance towards edible value and roughage quality of wheat and appears to be at the expense of other constituents of lesser commercial significance. Results obtained are statistically significant.

Utilization of growth promoting substances present in these aquatic plant extracts are known to boost crop productivity. Present investigation has been made explore the possibilities of utilisation of these duck-weed to boost the productivity of different crop growing in Banda district as well as Bundelkhand region.

VII-12 **EFFECT OF UV-B RADIATION ON SEEDLING GROWTH AND CHLOROPHYLL CONTENT OF *VIGNA* SPECIES**, G.K. DHINGRA* & V.K. JAIN, Department of Botany, Govt. P.G. College, Rishikesh-249 201.
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Effect of daily exposure of UV-B radiation on seed germination, seedling growth and chlorophyll development in mung and urd bean grown in Petridishes have been observed in the present investigations. Data shows that seed germination was least

INFLUENCE OF *Spirodella polyrhiza* EXTRACTS ON JUVENILE SEEDLING GROWTH AND DEVELOPMENT OF WHEAT

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ABSTRACT

Effect of water and ether extracts suspended in water of *Spirodella polyrhiza* on juvenile seedling growth of wheat variety "U.P. - 2338" has been studied by pre-soaking seed treatment. Results suggest that growth and development of both root and shoot is promoted following pre-soaking seed treatment with 1.0 percent extract. Observations are proven with possibilities of better prospective yield of wheat in treated plants. Results obtained are statistically significant.

Key words- (*Spirodella polyrhiza* wheat, growth and development)

INTRODUCTION

There is evidence of growth promoting substances in extracts of variety of plant materials (Mowat[8] Maheshwari and Bhatia[7] Shukla and Gupta[11] Pronano and Greene[10] Bhalla[2], Gupta and Agarwal[13], Pandey[9], Shukla[14, 16]). Such plant extracts have been utilized to boost growth, development and yield of various crop plants. The topic on Agricultural application of plant extracts for improved yield and altering quality of produce has been reviewed earlier (Shukla[15, 16])

Lemnoids are known for their wide spread occurrence in south-east Asia. *S. polyrhiza* particularly exhibits massive infestation at Banda. Present investigation deals with effects of *S. polyrhiza* extracts on growth and development of wheat seedling. *S. polyrhiza* was particularly chosen as experimental material for obtaining extract in view of its availability in large quantities in the area and homogeneity of structure for uniform extraction.

MATERIAL AND METHODS

Seeds of wheat variety "U.P. - 2338" were obtained from Economic Botanist,

C.S. Azad University of Agriculture and Technology, Kanpur. Seeds of approximately same size and weight were selected for experiments.

S. polyrhiza was obtained from nature and grown in laboratory under *in-vitro* cultural conditions. Healthy plants of *S. polyrhiza* were collected for obtaining water and ether extracts. Five ml. of *S. polyrhiza* material by volume was ground in ether or water in a porcelain mortar. In case of water extracts sufficient water was added to give 100 ml of 5.0 percent extract. In ether extracts ether was allowed to evaporate and suspension was made in 100 ml distilled water. Two and 1.0 percent extracts were made further dilution with distilled water. Fifty seeds were soaked in sterilized petridished in different concentrations (1.0, 2.0 and 5.0 percent) of water and ether extracts of *S. polyrhiza* and distilled water (Control) for 6,12, and 24 hours. Desired concentration used on experiments to study various parameters are specified separately below. Immediately after the soaking period seedlings were grown in test tubes filled with distilled water on equal sized filter papers following Garrard's Technique. The experiments were carried out at atemperature of 20° - 24°C, the normal temperature range of crop in nature. Observation were made 48,72 and 96 hours on length of main root, number of secondary roots and length of shoot. Seedlings were preserved as herbarium specimens.

OBSERVATION

A perusal of table I, II and III indicates that juvenile seedling growth of wheat plants show that out of various concentrations (1.0,2.0 and 5.0 percent) of extracts tried, 1.0 percent extracts exhibits all round maximum beneficial growth. Length of primary root, number of secondary roots and length of plumule exhibit marked increase with 1.0 percent extracts (except 6 hrs soaking with water extract where 2.0 percent is more effective).

DISCUSSION

Response of root and shoot growth of wheat seedlings to pre-soaking seed treatment with *S. polyrhiza* extracts exhibits marked beneficial effect. Treatments with 1.0 percent extract exhibits maximum effects on length of primary root, number of secondary root and length of plumule (except 6 hrs. soaking with water extract where 2.0 percent is more effective).

There is uniform all round, maximum effectiveness of extracts in concentration of 2.0 percent ether and 1.0 percent water in 6 hrs. 1.0 percent ether and 1.0 percent in 12 hrs and 1.0 percent ether and 1.0 percent water in 24 hrs of *S. polyrhiza*. Evidently ether extracts of *S. polyrhiza* are more effective than ether extracts.

Increase under 6 hrs treatments in length of primary root, number of secondary roots and length of plumule increased 23.76, 55.76 and 85.74 percent with 1.0 percent ether extract respectively. However, increase in length of primary root, number of secondary roots and length of plumule were found to be 34.61, 64.09 and 89.67 percent with 2.0 percent water extract respectively during present investigation on expiry of experiments after 96 hrs. Increase under 12 hrs. treatments in length of primary root, number of secondary roots and length of plumule were increased 29.17, 40.93, and 75.12 percent with 1.0 percent ether extract respectively. Increases in length of primary root, number of secondary roots and length of plumule were found to be 26.93, 55.48 and 67.35 percent with 1.0 percent water extract respectively during present investigation on expiry of experiment after 96 hrs. Increase under 24hrs treatments in length of primary root, number of secondary roots and length of plumule increased 46.93, 42.95 and 91.90 percent with 1.0 percent ether extract respectively ,but increase in length of primary root number of secondary roots and length of plumule were found to be 39.79, 60.64 and 96.94 percent water extract respectively.

Observation emphasize that in general effects of 12.0 hrs treatment with both ether and water extract is better as compared to 6 and 24 hrs treatments. Stimulatory effect of treatments gradually declines with pre-soaking seed treatment periods and 24 hrs

There is existence of extensive literature on effect of natural plant extracts on variety of plants (Shukla and Gupta[11], Shukla[12, 13, 14] Shukla and Shukla[15]) Benificial effect of naturally occurring growth substances of various plant extract like *Phormidium foveolarum* and *P. tenue* on rice (Shukla[12 16]) *P. foveolarum* on *Phaseolus aurens* (Gupta and Gupta[4]), *Vigna catjang* (Gupta and Gupta[5]); wheat (Kushwaha and Gapta[7]), *Spirodella polyrhiza* extracts on barley (Pandey[9]) and *Wolffia arrhiza* extract on wheat (Awasthi[1]). Present observations are in general agreement with previous

TABLE 1 : Effect of 6 hours Pre-soaking Seed Treatment with *Spirodella polyrhiza* Extracts on Juvenile Seedling growth.

ETHER EXTRACT

Age of Seedlings	Length of Primary root in CM				No. of Secondary Roots				Length of Plumule in CM			
	C	1%	2%	5%	C	1%	2%	5%	C	1%	2%	5%
48 HRS	2.56	4.03	3.42	2.81	2.12	3.64	3.01	2.44	1.13	2.06	1.67	1.41
72 HRS	4.73	6.51	5.66	5.20	2.62	4.53	3.86	3.22	3.86	5.75	5.10	4.56
96 HRS	5.85	7.24	6.93	6.11	3.21	5.00	4.74	4.30	5.05	9.38	8.24	7.91
	C.D.=0.25 Differene :96 HRS 1%-Control =1.39				C.D. =0.39 Difference :96 HRS 1%-Control =1.79				C.D. =1.55 Difference :96 HRS 1%-Control =4.33			

WATER EXTRACT

Age of Seedlings	Length of Primary root in CM				No. of Secondary Roots				Length of Plumule in CM			
	C	1%	2%	5%	C	1%	2%	5%	C	1%	2%	5%
48 HRS	2.12	3.10	3.91	2.52	2.04	2.58	3.41	2.13	1.09	1.35	2.10	1.14
72 HRS	4.31	5.24	6.33	5.03	2.51	2.92	4.10	2.32	3.85	5.68	6.23	4.61
96 HRS	5.20	6.62	7.00	6.38	2.98	3.48	4.89	3.17	4.94	8.12	9.37	6.91
	C.D.=0.58 Differene :96 HRS 2%-Control =1.80				C.D. =0.31 Difference :96 HRS 2%-Control =1.91				C.D. =1.53 Difference :96 HRS 2%-Control =4.43			

Abbreviations used : C = Control. C.D.= critical difference.

TABLE 2 : Effect of 12 hours Pre-soaking Seed Treatment with *Spirodella polyrhiza* Exctracts on Juvenile Seedling growth.

ETHER EXTRACT

Age of Seedlings	Length of Primary root in CM				No. of Secondary Roots				Length of Plumule in CM			
	C	1%	2%	5%	C	1%	2%	5%	C	1%	2%	5%
48 HRS	2.93	4.33	3.86	3.02	2.24	3.71	3.18	2.58	1.45	2.34	2.00	1.76
72 HRS	6.86	9.15	8.75	8.21	2.86	4.83	3.91	3.42	5.81	7.71	6.12	5.84
96 HRS	9.22	11.91	10.53	9.98	3.64	5.13	4.00	3.79	6.03	10.56	8.93	8.06
	C.D.=0.74 Differene :96 HRS 1%-Control =2.69				C.D. =0.37 Difference :96HRS 1%-Control =1.49				C.D. =1.67 Difference :96 HRS 1%-Control =4.53			

WATER EXTRACT

Age of Seedlings	Length of Primary root in CM				No. of Secondary Roots				Length of Plumule in CM			
	C	1%	2%	5%	C	1%	2%	5%	C	1%	2%	5%
48 HRS	2.81	4.12	3.40	2.94	2.07	3.70	3.00	2.21	1.23	2.12	1.76	1.42
72 HRS	6.53	8.78	7.87	7.65	2.15	4.35	3.28	2.66	4.74	6.56	6.11	5.33
96 HRS	8.95	11.36	10.00	9.14	3.19	4.96	3.84	3.43	5.88	9.84	8.65	7.69
	C.D.=0.68 Differene :96 HRS 1%-Control =2.41				C.D. =0.31 Difference :96 HRS 1%-Control =1.77				C.D. =1.33 Difference :96 HRS 1%-Control =3.96			

Abbreviations used: C=Control, C.D.=critical difference.

TABLE 3 : Effect of 24 hours Pre-soaking Seed Treatment with *Spirodella polyrhiza* Exctracts on Juvenile Seedling growth.

ETHER EXTRACT

Age of Seedlings	Length of Primary root in CM				No. of Secondary Roots				Length of Plumule in CM			
	C	1%	2%	5%	C	1%	2%	5%	C	1%	2%	5%
48 HRS	2.05	3.58	2.21	2.10	2.11	3.28	2.46	2.21	1.00	1.97	1.56	1.18
72 HRS	4.12	6.00	5.48	5.03	2.38	3.61	2.84	2.53	2.63	4.74	3.82	3.03
96 HRS	4.88	7.17	6.31	5.96	2.91	4.16	3.78	3.40	4.20	8.06	7.92	734
	C.D.=0.64 Differene :96 HRS 1%-Control =2.29				C.D. =0.27 Difference :96 HRS 1%-Control =1.25				C.D. =1.65 Difference :96 HRS 1%-Control =3.86			

WATER EXTRACT

Age of Seedlings	Length of Primary root in CM				No. of Secondary Roots				Length of Plumule in CM			
	C	1%	2%	5%	C	1%	2%	5%	C	1%	2%	5%
48 HRS	2.00	3.23	2.64	2.14	1.91	3.11	2.18	2.06	0.96	2.01	1.11	1.00
72 HRS	3.71	5.97	4.88	4.38	2.13	3.96	2.63	2.17	3.13	5.84	4.93	4.14
96 HRS	4.90	6.85	5.76	5.51	2.82	4.53	3.00	2.88	4.57	9.00	7.69	6.30
	C.D.=0.45 Differene :96 HRS 1%-Control =1.95				C.D. =0.38 Difference :96 HRS 1%-Control =1.71				C.D. =1.52 Difference :96 HRS 1%-Control =4.43			

Abbreviations used : C=Control, C.D.=critical difference.

reports. They also exhibit a similar trend of promotion in growth and developmental wheat seedlings following treatments with

S. polyrhiza extracts. Present findings are suggestive of better crop prospects should these extracts are applied in agriculture of wheat crop.

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EFFECT OF *Spirodella polyrhiza* EXTRACTS ON STOMATAL AND EPIDERMAL DEVELOPMENT IN WHEAT LEAVES

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ABSTRACT

The influence of different concentrations (1 and 2 percent) of water and ether extracts of ***Spirodella polyrhiza***. suspended in water on stomatal and epidermal development of ***Triticum aestivum***. leaves has been studied after pre-soaking the seeds. Treatments for 6 hrs with one per cent water extracts gave maximum increase in number of epidermal cells, number of stomata, length of epidermal cell, breadth of epidermal cell, perimeter of stomatal pore, length of guard cells and breadth of guard cells. The results demonstrate an overall change in morpho-anatomy of the leaf, acquiring better adaptability for gaseous exchanges vital for photosynthetic activity. The results were statistically significant.

INTRODUCTION

There has been growing concern about rapid spread and luxuriant infestation of duck-weeds in tropical and sub-tropical regions of the world. Naturally, such massive growth of duck-weeds is proven with possibility how best it could be harnest to benefit mankind. ***S. polyrhiza*** of the duck-weeds explored for its extracts to investigate their response to synthesis in wheat variety 'U.P.-2338'. Wheat production is of pivotal importance to meet problem of malnutrition in both human beings and cattle. There is evidence for growth-promoting and inhabitory substances in extracts of a variety of plant materials (Matzger and Zeevaart, 1980; Albone et al. 1984; Pontovich et al., 1984; Ahokas, 1985; Gaskin et al., 1985; Janaki and William, 1986; James and Marcia, 1986 and Prudence et al., 1986). The influence of growth substances on anatomical structure has also been reported by Torrey, 1953; Kennedy and Farrar, 1965; Cronshaw and Morey, 1965; Morey and Cronshaw, 1966; Weston and Thomas, 1980; Ting and Wren, 1980; Saks et al., 1984; Vreugdenhill et al.,

1984. However, there is little information on the influence of plant extracts on leaf anatomy of wheat. ***S. polyrhiza*** was chosen for extracting, since there is evidence for the presence of growth regulating properties in aquatic weeds (Sircar and Kundu.1959, 1960; Mukherjee et al., 1964; Nagar and Saha, 1985 and Fujioka et al., 1986) and homogeneity of structure for uniform extraction.

MATERIALS AND METHODS

Seeds of the wheat (***Triticum, aestivum***) variety U.P.-2338 were obtained from Economic Botanist, C. S. Azad University of Agriculture and Technology, Kanpur, India. Seeds of approximately the same size and weight were selected for experiments.

Spirodella polyrhiza was obtained from nature and grown in the laboratory under ***in vitro*** cultural conditions (Pandey, 1979). The extraction! of ***S. polyrhiza*** were made in water or ether from healthy plants. As ether is injurious to plant growth, it was allowed to evaporate and the growth promoting substances were suspended in water. Five millilitre of ***S. polyrhiza*** by volume was ground in a clean porclain mortor with 10 ml water or ether. In case of water extract sufficient distilled water was added to make it 100 ml to have a five percent extract. One and 2 per cent extracts were made by further dilution with distilled water. In case of ether extract ether was first allowed to evaporate and the suspension was than made to 100 ml in distilled water. One 2 and 5 per cent extracts were made by further dilution with distilled water. Fifty seeds were soaked for 6, 12 and 24 h in sterlized petridishes in different concentrations (1, 2 and 5 per cent) of water and ether extracts of ***S. polyrhiza***, and distilled water (control).

Effect of 6, 12 and 24 h pre-soaking seed treatment with 1 per cent water and 2 per cent ether extracts of ***S. polyrhiza*** on stomatal and epidermal development of wheat seedlings, variety "U.P.-2338" was studied following technique suggested by Shukla (1967). Treated wheat seedlings were allowed to grow for 144 h. Second leaf of seedlings from base in different treatment was collected and preserved in alcohol (Llyod, 1908). The stomatal and epidermal studies were made from peelings of leaves. Both upper and lower epidermal peelings were taken out and stained preparations were observed microscopically. One per cent water and 2 per cent ether extracts were chosen for observing anatomical response of wheat leaves because out

of various concentrations used to study seedling growth, these concentrations were found to be beneficial to the maximum extent. Observation on number of stomata, perimeter of single stomatal opening, number of epidermal cells, length of epidermal cells, and length and breadth of guard cells were made in an area of 1984 sq ***m*** of leaf peelings. Average of 25 replicates were taken into consideration.

The data was analysed statistically following analysis of variance method at 5 per cent error probability for testing the significance of the effect of treatments. Results of statistical analysis are entered in respective observation tables.

OBSERVATIONS

An examination of Table-1 shows that number of epidermal cells per microscopic field, number of stomata per microscopic field, length of epidermal cell, breadth of epidermal cell, perimeter of stomatal pore, length of guard cells and breadth of guard cells increased 14.00, 60.73, 16.02, 15.18, 16.71, 10.90 and 42.40; 9.80, 46.52, 46.21, 19.50, 24.02, 11.01 and 24.59, 6.99, 75.58, 9.61, 12.08, 13.28, 11.59 and 40.58 per cent over control with ether extract and 4.75, 28.86, 5.34, 4.56, 10.05, 6.39 and 22.24; 4.78, 21.66, 31.53, 11.78, 12.49, 5.83 and 12.82; 3.54, 70.50, 7.13, 3.59, 3.90, 4.19 and 17.69 percent over control with water extract under 6, 12 and 24 hrs treatments respectively on upper epidermis of leaves.

A perusal of Table-II exhibits that number of epidermal cells per microscopic field, number of stomata, length of epidermal cell, breadth of epidermal cell, perimeter of stomatal pore, length of guard cells and breadth of guard cells increased 9.16, 21.45, 11.39, 18.59, 3.09, 5.24 and 25.68; 10.66, 47.52, 12.77 8.19, 15.34. 7.90, and 30.23; 10.34, 79.66, 12.38, 15.87, 4.38, 2.78 and 22.38 per cent over control with ether extract and 8.21, 17.43, 9.18, 12.10, 1.51, 4.05 and 18.84; 5.68, 22.98, 10.31, 6.19, 7.91, 2.93 and 20.10; 5.47, 74.15, 10.00, 7.28, 2.98, 1.59 and 20.07 per cent over control with water extract under 6, 12 and 24 hrs treatments respectively on lower epidermis of leaves.

DISCUSSION

Exhaustive literature on utilisation of algal extracts of ***Phormidium foveolarum*** in agriculture of rice (Gupta and Shukla, 1964, 1967, 1969; Shukla and Gupta, 1967; Shukla, 1968, 1975 a); wheat (Kushwaha and Gupta, 1970 a, 1970

b, Shukla, 1975 b), ***Vigna catzang*** (Gupta and Gupta, 1970, 1972, 1973) and ***Phaseolus aureus*** (Gupta and Gupta, 1972) is available. Likewise, stimulation in vegetative growth and yield of rice following treatments with water hyacinth extracts has also been reported (Sircar, 1963). Influence of ***Lemna paucicostata*** manure and spraying with its extracts on ***Hordeum Vulgare*** was explored by Pandey (1979) and the study revealed significant effects on fresh dry matter production, yield, ascorbic acid, catalalse, chlorophyll and epidermal structure of plants.

The physiological pecularities of plants in general and rice in particular (Sircar, 1958) are known to possess different auxin levels at various sites which appears to control growth and development pattern in various parts of the plants. A high IAA content of endosperm regulates germination and seedling growth in rice (Sircar and Das, 1954). It has been suggested that auxin level in rice occurs in two parts. A bulk of auxin remains in inactive form in vacuole and active auxin part below suboptimal concentration is found at the sites of 'growth to bring about stimulation. Exogenous supplies of other growth regulators, sets in a competition between native IAA and exogenous growth regulators which displaces native auxin from its natural site of action leading to higher concentration of free auxin to exercise stimulated growth (Sircar, 1958).

It may be suggested that a similar auxin level controlled mechanism as referred to earlier in case of rice may be operative in wheat under exogenous supply of growth substances present in ***S. polyrhiza*** extracts.

The stomata are principal portals through which gaseous exchanges take place between the intercellular spaces and surrounding atmosphere. The efficiency of stomatal apparatus in controlling gaseous exchanges of the plants was extensively studied by Brown and Escombe (1900), who have pointed out that the rate of diffusion through small openings (like stomata) in a given period of time is proportional to the perimeter and not to the area of pore. The greater the perimeter the more rapid is the rate of diffusion. Earlier observations of Shukla (1967) ravealed that application of 1 per cent extract of ***Phormidium foveolarum*** reduces the size of stomata in treated rice plants but increase their number and perimeter. Consequently, it was suggested that there would be more rapid diffusion of carbondioxidc in the

leaves of treated rice plants. Similar influence of algal extracts on stomatal and epidermal development of wheat leaves (Shukla, 1975 b) and synthetic growth substances on maize leaves has been recorded earlier (Shukla and Shukla, 1975).

The crude fresh extract of ***S. polyrhiza*** plants applied to wheat crop appears to contain growth substances. Interestingly containing such a mixture of substances that provide an ideal blending of growth factors sufficiently endowed to give general boost to the crop expressed in terms of altering morpho-anatomy of wheat crop.

Present findings emphasized the significance of ***S. polyrhiza*** infestation, and how best they could be utilized for obtaining extracts which possess tremendous capacity to stimulate stomatal and epidermal development. The stomatal and epidermal structure also acquired better adoptability for gaseous exchanges vital for photosynthetic activity. This may partly explain the beneficial effect of ***S. polyrhiza*** extracts on the growth of wheat plant.

The investigation opens up wide vistas for further exploration and enquiry in intricate aspects concerned with utilizing the technology with success in future with new influx of varieties to boost wheat productivity in time and space. Implementation of these growth promoting substances containing extracts wheat agriculture to meet human hunger and malnutrition is only possible when these experimental findings are wedded to practice.

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STUDIES ON EFFECT OF *Spirodella polyrhiza* EXTRACTS ON MORPHO-ANATOMY OF WHEAT STEM

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ABSTRACT

Influence of different concentrations (2 and 1 percent) of water and ether extracts suspended in water on anatomical structure of stem of wheat has been studied by pre-soaking seed treatment. Effect of *S. polyrhiza* extracts on stem anatomy of wheat have shown promising results. Six twelve and Twentyfour hrs treatments with ether extract exercises maximum increase in diameter of xylem, phloem and number of vascular bundles in stem. Results emphasize an overall change in morpho-anatomy of stem to provide better conductions and facilitate better vegetative growth and yield. Results obtained are statistically significant.

Tables : 01 figures : 00 References : 37

Key Words : Wheat, *Spirodella polyrhiza*, Stem Anatomy

INTRODUCTION

There is evidence of growth-promoting substances in extracts of a variety of plant materials URadlcy, 1956; Jackson and Coombe, 1966; Maheshwari and Bhatia, 1966; Bhalla, 1977.MacMillan.l977; Matzgcr and Zeevaart, 1980; Albone et. al., 1984; Bhowmick and Basu, 1984; Pontovich et. al. 1984; Ahokas 1985; Gaskin et al. 1985; Sponsel, 1985; Janaki and William. 1986; James and Marcia, 1986 and Prudence et. al., 1986). Influence of growth substances with reference to anatomical structure has also been reported by Torry (1953), Roberts (I960), Kennedy and Farrar (1965) Cronshaw and Morey (1965), Morey and Cronshaw (1966), Weston and Thomas (1980), Ting and Wren (1980), Thompson et. al. (1983), Krizek and Mandava (1983) Saka el. al. (1984), Vreagenhill et. al. (1984). However, there is

dearth of literature concerned with the influence of extracts of plant material to the anatomical structure. (Awasthi and Shukla, 1986, 1989) Present investigation deals with effects of *S. polyrhiza* extracts on stem anatomy of wheat. *S. polyrhiza* was particularly chosen as experimental material for obtaining extracts in view of evidence for the presence of growth regulating properties in the aquatic weeds (Sircar and Kundu, 1959; 1960; Mukherjee et. al., 1964, Nagar and Saha, 1985 and Fujioka et. al., 1986) and homogeneity of structure for uniform extraction.

MATERIAL AND METHODS

Seeds of wheat variety 'U.P.- 2338' were obtained from Economic Botanist, C. S. Azad University of Agriculture and Technology, Kanpur, India. Seeds of approximately same size and weight were selected for experiments.

S. polyrhiza was obtained from nature and grown in laboratory under in vitro cultural conditions. Healthy plants of *S. polyrhiza* were collected for obtaining water and ether extracts. The extractions of *S. polyrhiza* were made in water or ether. As ether is injurious to plant growth it was allowed to evaporate and growth promoting substances were suspended in water. Five millilitre of *S. polyrhiza* by volume was taken and ground in a clean porcelain mortar with water or ether. In case of water extract sufficient distilled water was added to make it 100 ml and get five per cent extract. One and 2 per cent extracts were made by further dilutions with distilled water. In case of ether extract ether was first allowed to evaporate and then suspension was made in 100 ml in distilled water. One, 2 and 5 per cent extracts were made by further dilution with distilled water. Fifty seeds were soaked in sterilized petridishes in different concentrations (1,2 and 5 percent) of water and ether extracts of *S. polyrhiza*, and distilled water (control) for 6, 12 and 24 hrs

The effect of treatments was studied under field conditions in the garden beds laid for specific purpose with dimensions 8 feet in breadth and 10 feet in length. Each bed was sown with 3 rows containing 9 seeds spaced 25 cm in rows 60 cm apart. Thus total number of plants grown in each bed were 27 out of which 25 were selected for observations. Two beds of each treatments and normal untreated control were laid to raise 50 replicates. Seeds of wheat variety 'U.P.-2338' 1 percent water and 2 per cent ether extracts were chosen for observing effects under normal field

conditions as out of various concentrations used to study seedling growth, these concentrations were found to be beneficial to the maximum extent and therefore, it was thought to study sustained effect of such treatments on subsequent nature of wheat stem. Garden beds were prepared after ploughing the area and mixing adequate amount of manure in ratio of 3 parts of soil and 1 part of cowdung manure in upper crust of soil. Seeds soaked in distilled water were similarly sown and served as control. The matured crop was harvested after 105 days and material of stem was cut carefully from both treatments (1 per cent water and 2 per cent ether) and control. Stem pieces of 2 cm were collected from 5 cm below the top of the plant. Such materials of each treatment were preserved in formalin aceto-alcohol, in a mixture containing 90 ml of 70 percent ethyl alcohol, 5 ml. glacial acetic acid and 5 ml formalin. The material was then dehydrated and was microtomed using senior Rotary Microtome Model MT 1090 A. Slides of materials prepared were stained in safranin and fast green following Johansen's (1940) technique. Observations on diameter of stem, number of vascular bundles, diameter of xylem and phloem and diameter of xylem were recorded and average of 50 replicates taken into consideration. Results obtained were statistically analysed following "Analysis of variance" method to pinpoint significance of treatments at 5 per cent error probability.

OBSERVATIONS

Observations on diameter of stem, number of vascular bundles, diameter of xylem and phloem and diametar of xylem tissue have been recorded in Table 1. A perusal of data entered in Table shows that diameter of xylem tissue, diameter of phloem tissue, diameter of stem, diameter of metaxylem, diameter of protoxylem and number of vascular bundles increased 23.02, 19.88, 13.86, 27.97, 7.66, and 39.90; 24.00, 23.49, 11.55, 16.80, 8.65 and 27.87; 26.14, 31.93, 39.35, 33.52, 17.36 and 40.71 percent over control with ether extract (1 per cent) under 6, 12 and 24 hrs treatments respectively in stems. Diameter of xylem tissue, diameter of phloem tissue, diameter of stem, diameter of metaxylem, diameter of protoxylem and number of vascular bundles increased 11.35, 5.50, 7.80, 22.38. 3.70, and 22.72; 8.97, 7.90, 10.99, 11.81, 2.68, and 18.06; 16.48, 16.32, 34.81, 18.29, 14.11 and 19.56 per cent over control in 6, 12 and 24 hrs treatments respectively in stems with water

extract (2 per cent).

DISCUSSION

A perusal of results on the effect of *S. polyrhiza* extracts on diameter of xylem, phloem and number of vascular bundles shows a marked alteration. The xylem-phloem and ground tissue ratio is concomittantly effected. The increase in xylem-phlocm tissue appears to be at the expense of cortex and ground tissue.

The number of tracheary elements found in the tension wood induced by DNP in some seedlings are either equivalent or in others slightly reduced, relative to the number of tracheary elements present in xylem formed before treatment. In the Acer rubrum system (Morey, 1968a; 1968b) it is probable that the relative frequency at which trecheary elements are initiated from the fusiform initials related to the level of auxin in the system below the DNP treatment site where tracheary elements are initialed from the deviding intitials or adjacent to them. It seems inconsistant, on the other hand that the capacity of DNP to induce the formation of tension wood in the same region of the stem is explained in terms of developmental response to auxin deficiency. However, the cambial derivatives undergoing secondary wall development namely the xylem element in the wall thickening phase of development are segregated from the cambial initials by more or less arbitrary zone of cells in which the walls are expended by surface growth (Morey and Cronshaw, 1966). In this regard DNP may be more effective in lowering the auxin level in the cetripetal zone of the stem than in the peripheral peristematic region.

This synoptical background about development of trancheids is clearly indicative of the fact that development of xylem is linked with auxin level in stem. Auxin deficiency stimulates development of xylem. Exogenous supplies of certain growth substances blocked polar transport of auxin in area just above the region of blockade (Cronshaw and Morey, 1965; Jackson and Stead, 1984). During present investigation exogenous supply of growth substances in extracts of *S. polyrhiza* administered through pre-soaking seed treatment appear to set in some kind of competition with the endogenous auxin levels and displaces auxin through polar transport to the extremities of stem to initiate its apical growth, and in the process create conditions of auxin deficiency in the older region of the organs, thereby stimulating

development of xylem in the stem. This may explain the increased formation of xylem, phloem and ground tissue observed during present investigation.

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RESPONSE OF WHEAT ROOT ANATOMY TO *Spirodella polyrhiza* EXTRACTS

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ABSTRACT

Influence of water and ether extracts suspended in water of ***spirodella polyrhiza*** on root anatomy of wheat has been studied by presoaking seed treatment. There is a uniform alround maximum effectiveness of 1 per cent ether extracts of ***S.polyrhiza***. Six, twelve and twenty four hours treatments with ether extract of ***S.polyrhiza*** exercised maximum increase in xylem, phloem and ground tissue to the maximum extent. Results obtained were found to be statistically significant.

Tables : 01 figures : 00 References :41

Key Words : Wheat, *Spirodella polyrhiza*, Root Anatomy

INTRODUCTION

There is evidence of growth-promoting substances in extracts of a variety of plant materials (Radley, 1956, 1958; Mowat, 1963; Jackson and Coombe, 1966; Maheshwari and Bhatia, 1966; Gupta and Shukla, 1967; Bhalla, 1977; MacMillan, 1977; Matzger and Zeevaart, 1980; Albone et al., 1984; Auerman et. al., 1984; Banas et al., 1984; Bhowmick and Basu, 1984; Driss-Ecole et al., 1984; Kandil et al., 1984; Murti and Raja Rao, 1984; Pontovich et al., 1984; Pudir et al., 1984; Ahokas, 1985; Gaskin et al; 1985; Nagar and Saha, 1985; Sponsel, 1985; Janaki and William, 1986; James and Marcia, 1986 and Prudence et al., 1986; Awasthi, 1986).

Despite abundance of literature concerned with anatomy of various plants there is dearth of literature on influence of growth promoting substances vis-a-vis anatomy of plant systems. However, works of Torrey (1953), Roberts (1960), Kennedy and Farrar (1965), Cronshaw and Morey (1965) and Morey and Cronshaw (1966)

Awasthi and Shukla (1986, 1989) on influence of growth substances with reference to the anatomical structure have been reported elsewhere.

Lemnoids are known for their wide spread in South—East Asia. ***S. polyrhiza*** particularly exhibits massive infestation in Banda. Present investigation deals with effects of ***S. polyrhiza*** extracts on anatomy of wheat root. ***S. polyrhiza*** was particularly choosen as experimental material for obtaining extracts in view of the evidences for presence of growth regulating properties of the aquatic weed (Sircar and Kundu, 1959, 1960; Mukherjee et al., 1964) and homogeneity of structure for uniform extraction.

MATERIAL AND METHODS

Seeds of wheat variety "U.P.-2338" were obtained from Economic Botanist, C.S. Azad University of Agriculture and Technology, Kanpur, India. Seeds of approximately same size and weight were selected for experiments.

S. polyrhiza was obtained from nature and grown in laboratory under ***in vitro*** cultural conditions. Healthy plants of *S. polyrhiza* were collected for obtaining water and ether extracts. The extractions of ***S. polyrhiza*** were made in water or ether. As ether is injurious to plant growth it was allowed to evaporate and growth promoting substances were suspended in water. Five millilitre of ***S. polyrhiza*** by volume was taken and ground in a clean porcelain mortar with water or ether. In case of water extract sufficient distilled water was added to make it 100 ml for obtaining 5 per cent extract. One and 2 per cent extracts were made by further dilutions with distilled water. In case of ether extract, ether was first allowed to evaporate and the suspension was then made to 100 ml in distilled water. One, 2 and 5 per cent extracts were made by further dilutions with distilled water. Fifty seeds were soaked in sterilized petri-dishes in different concentrations (1, 2 and 5 per cent) of water and ether extracts of ***S. polyrhiza***, and distilled water (control) for 6,12 and 24 hours. Studies on effect of ***S. polyrhiza***, extracts on anatomy of wheat plant, variety "U.P. - 2338" were made following usual techniques of fixation of desired parts of material. Material of root was cut carefully from both treated (1 per cent water and 2 per cent ether extracts of ***S. polyrhiza***) and normal untreated plants served as control. Treated seeds were grown over filter papers following Garrard's

(1954) technique and roots were collected after seedlings obtained 144 hrs age. Seeds of wheat variety "U.P.-2338", 1 per cent water and 2 per cent ether extracts were choosen for observing anatomical responses of wheat roots, because out of various concentration used to study seedlings growth, these concentrations were found to be beneficial to the maximum extent and therefore, it was thought to study sustained effect of such treatments on subsequent nature of wheat roots. In view to obtain uniform effects of treatments pieces of roots were carefully selected from 5 mm below root-shoot transitition zone. Such materials of each treatment were preserved in formalin aceto-alcohol (in mixture of 5 ml glacial acetic acid and 5 ml formalin). The material was then dehydrated and was micro-tomed using Senior Rotary Microtome Model MT 1090 A. Slides of materials prepared were stained in safranin and fast green following Johansen's (1940) technique. Observations on diameter of root, diameter of stele, diameter of vascular bundles, number of protoxylem, number of metaxylem and number of root hair were recorded. Results expressed are average of twenty five replicates.

OBSERVATIONS

An examination of data entered in Table—1 shows that 12 hrs treatment is effective to the maximum extent. Influence of ether extract in 6, 12 and 24 hrs are more pronounced. Increase in diameter of root, diameter of stele, diameter of vascular bundle, diameter of metaxylem, number of protoxylem and number of root hair increased 8.81, 17.65, 11.19, 11.15, 18.24 and 5.66; 13.57, 15.33, 10.44, 13.39, 13.46 and 13.05; 11.07, 14.26, 10.38, 16.47, 19.90 and 6.98 per cent over control in 6, 12 and 24 hrs treatments respectively in root with ether extracts. Likewise diameter of root, diameter of stele, diameter of vascular bandle, diameter of metaxylem, number of protoxylem and number of root hair increased 2.93, 4.72, 8.06, 5.56, 3.62 and 3.74; 7.04, 9.13, 7.10, 2.47, 3.48 and 6.05; 7.36, 5.20, 6.62, 8.39, 9.20 and 2.37; with water extract under 6, 12 and 24 hrs treatments respectively.

DISCUSSION

A perusal of results on the effect of ***S. polyrhiza*** extracts on diameter of xylem and phloem tissues and size of tracheids shows a marked alteration. The xylem-phloem and ground tissue ratio is concomitantly affected. The increase in

xylem-phloem tissue appears to be at the expense of cortex and ground tissue.

The number of tracheary elements found in the tension wood induced by DNP in some seedlings are either equivalent or in others slightly reduced interalia number of tracheary elements formed before treatment present in xylem. In ***Acer rubrum*** system (Morey, 1968 a, 1968 b) probability of relative frequency at which tracheary elements are initiated from the fusiform initials or adjacent to them has been suggested. It seems inconsistent, on the other hand that the capacity of DNP to induce the formation of tension wood in the same region of the stem is explained in terms of developmental response of auxin deficiency. However, the cambial derivatives undergoing secondary wall development, namely the xylem element in the wall thickening phase of development are segregated from the combial initials by more or less arbitrary zone of cells in which the walls are expanded by surface growth (Morey and Cronshaw, 1966). In this regard DNP may be more effective in lowering the auxin level in the centripetal zone of the stem than in the peripheral meristematic regions.

This synoptical background about development of tracheids in stem is clearly indicative of the fact that development of xylem is linked with auxin level. It appears that a similar auxin controlled trachied development in roots may be operative in wheat root. Auxin deficiency stimulates development of xylem. Exogenous supplies of certain growth substances blocked polar transport of auxin in area just above the region of blockade (Cronshaw and Morey, 1965; Jackson and Stead, 1984) During present investigation exogenous supply of growth substances in extracts of ***S. polyrhiza*** administered through pre-soaking seed treatments appear to set in some kind of competition with the endogenous auxin levels and displaces auxin through polar transport to the extremities of root and initiate its apical growth, and in the older regions of the organs, thereby stimulating development of xylem in the root.

There is evidence of gibbrellin like substance in extracts of ***Wolffia floridana*** (Pieterse et al., 1971). The nature of growth promoting of ***S. polyrhiza*** was studied and it was found to contain a gibberllin-like growth factor. Interestingly, the effect of crude extract containing this growth factor in mixture of other plant constituents stimulated and altered growth and development of wheat plants to a greater extent

than the gibberllin itself. Logically, it was considered more appropriate to use crude extract during present investigation rather than trying isolated growth factor of ***S. polyrhiza*** plants. Perhaps constituents other than gibbrellin-like factor may be functioning like co-factors thereby exercising more pronounced effects. This may explain increased formation of xylem, pholem and diameter of tracheids, observed during present investigation.

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